

THE *Anal.*

A N A T O M Y
O F T H E
H U M A N B O N E S , N E R V E S ,
A N D
L A C T E A L S A C A N D D U C T .

By ALEXANDER MONRO, *senior*, M. D. and F. R. S.
Fellow of the Royal College of Physicians, and
Professor of Medicine and Anatomy in the
University of Edinburgh.

A N E W E D I T I O N .

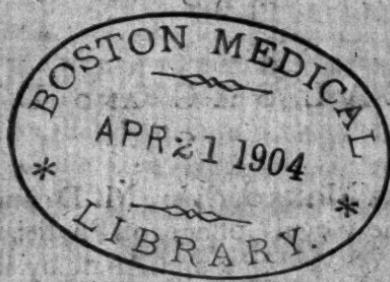
T O W H I C H I S A D D E D ,

A N
E S S A Y
O N
C O M P A R A T I V E A N A T O M Y .

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TO THE
STUDENTS of ANATOMY
N THE
UNIVERSITY of EDINBURGH.

GENTLEMEN,

WHEN this *Osteology* was first printed in 1726, I did not know that Albinus, Winslow, and Palfyn, were to publish descriptions of the bones; otherwise, my papers probably would have remained yet undelivered to the printers. I however flatter myself, that this *essay* has been of use to the gentlemen who did me the honour to attend my lectures, by assisting them to understand my sense and representation of things in this fundamental part of anatomy; and that it has possibly been of more advantage to them than a more complete work from an abler hand, unless my demonstrations had been in the order and method of such an author.

This view of your improvement, Gentlemen, is a prevailing argument with me to cause this *essay* to be reprinted; and you cannot reasonably blame me, if I likewise acknowledge another motive for it, which more particularly relates to myself. In a new edition, an author

has an opportunity of making his works more correct, complete, and consequently acceptable to the public, who may perhaps be indulgent enough to think this little treatise not altogether useless ; since more reasoning on the structure and morbid *phenomena* of bones is to be found in it, than in the other writers, who have confined themselves almost entirely to the descriptive or proper anatomical part of the *osteology*.

I have here kept to the plan of the former editions, by first considering, in the order that seemed to me most natural and methodical, every thing which I thought necessary to be known concerning bones in general ; and, in the second part, I have described the several bones composing the skeleton.

The bones of adults are what I principally endeavour to describe ; but I have added as much of the *osteogenea* as I think serviceable in the practice of physic and surgery.

That little might be omitted of what was formerly done on this subject, I have taken all the assistance I could from books ; but have never asserted any anatomical fact on their authority, without consulting nature, from which all the descriptions are made ; and therefore, the quotations from such books serve only to do justice to the authors, who have remarked any thing in the structure of the parts that was commonly omitted, and to initiate you in the history of anatomy ; which I once proposed to make complete, so far as related to this subject : But not being able to procure several books, and

and being sensible how many more may have never come to my knowledge, I laid aside this design, of purpose omitted many I could have inserted, and in some places I have changed an older author for a later one, who has more fully or clearly described what I treated of. Beside anatomists, I have also named several other authors to confirm my reasoning by practical cases; of which it is not to be supposed my own experience could furnish a sufficient variety.

You will readily observe, that I quote no passages with a view to criticise or condemn them. This precaution of giving no offence, is very necessary in those who are sufficiently conscious of their being liable to lay themselves open to just censure; and it prevents occasions of useless wrangling, in which generally both parties are losers, and the public has little advantage.

In this treatise I always make use of the most common name of each part, and have put the synonymous names to be met with in books at the foot of the page, that the reading might be smoother, and you might consult them at your leisure to assist you in understanding different authors.

The descriptions and reasoning are here blended, without which I always find young anatomists are soon disgusted with authors: Their imaginations cannot follow a long chain of descriptions, especially when they are not taught at the same time the uses which the described parts serve: Their minds must have some relaxation,

laxation, by a mixture of reasoning, which never misses to strike the fancy agreeably, and raises a strong desire to understand the principles on which it depends.

The *phenomena* of diseases are all deduced in this essay from the structure of the parts, by way of corollaries and questions; which such an anatomical work confined me to. And this method has otherwise a good effect: For, when one meets with an useful proposition, and is obliged to employ a little thought to find out its solution, the impression it makes is deeper, and he acquires a fondness for it, as being, in part, his own discovery. My pupils have frequently assured me, that they could, with very small reflection, trace out the whole reasoning from which my conclusions were drawn; I hope their successors will also think this an agreeable manner of being instructed.

Those gentlemen who desired I would add the lectures which I pronounced in my colleges as a commentary upon the text, where the diseases are mentioned, will, I persuade myself, excuse me for not complying with their desire, when they consider the design of this is to be a school-book, and how great the difference is between instructing youth in private, and pretending to inform the public. *Art. xxiv. vol. v. of Medical Essays and Observations*, published in this place, is one of these lectures which I gave as a commentary on the paragraph (p. 9.) concerning the different kinds of *caries*.

In this edition, I have corrected the mistakes and obscure passages which I discovered in the former;

former ; and, in some places, I have made the descriptions more full and exact, aiming all I could to shun unnecessary minuteness on the one hand, and a blameable inaccuracy on the other : Whether I have hit that just medium, is what you and the public must now judge.

I am still of opinion, that figures of the bones would at any rate have been unnecessary in a book that is intended to be illustrated and explained by the originals themselves ; but would be much more so now, when my late ingenious friend Mr. Cheselden, Dr. Albinus, and Mr. Sue (*a*), have published such elegant ones.

You have advantageous opportunities in this place of studying all parts of medicine, under the professors of its different branches in the University, and of seeing the practice of pharmacy, surgery, and physic, with our surgeon-apothecaries, and in the Royal Infirmary, where the diseased poor are carefully treated. These, your interest, and, I hope, your inclinations, will lead you, Gentlemen, so to improve, as that they may become the happy means of your making a considerable figure in your several stations. Whatever assistance is in my power towards such a desirable event, shall be given with the greatest pleasure by

Your humble servant,

ALEX. MONRO.

(*a*) *Traité d'ostéologie*, traduit de l'Anglois de M. MONRO, seconde partie.

the same place. I have made the
same mistake before, but this time I
will not do it again.

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188. 1900-1901. 1902-1903. 1904-1905.

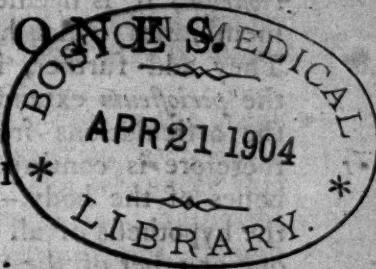
THE ANATOMY

OF THE

HUMAN BONES.

PART I*

Of the BONES in general.



BONES are covered by a membrane, named, on that account, PERIOSTEUM*, which is so necessary to them, that we must examine its texture and uses, before we can understand their structure.

The *periosteum*, as well as most other membranes, can be divided into *layers* of fibres. The *exterior* ones, composed of the fibres of the muscles connected to the bones, vary in their number, size, and direction, and consequently, occasion a very great difference in the thickness and strength of the *periosteum* of different bones, and even of the different parts of the same bone. The *internal* layer is every where nearly of a similar structure, and has its fibres in the same direction with those of the bone to which they are contiguous. Ought not then the name *periosteum* to be applied, strictly speaking, only to this internal layer, to which the others are joined in an uncertain manner and number?

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* Membrana circumossalis, omentum ossibus impositum.

2 OF THE BONES IN GENERAL.

Some authors (*a*) endeavour to prove the internal layer of fibres of the *periosteum* to be derived from the *dura mater*: For, say they, since the membrane covering the scull is plainly a production or continuation of the *dura mater*, which passes out between the sutures; and since there are muscles on the head, as well as in other parts, which might furnish a *periosteum*, it is needless to assign different origins to membranes which have the same texture and uses. They add further, in proof of this doctrine, that the *periosteum* extends itself along the ligaments of the articulations from one bone to another; and therefore is continued from its origin over all the bones of the body.—While anatomists were fond of the hypothesis of all membranes being derived from one or other of the two that cover the brain, a dispute of this kind might be thought of consequence: But, now that the hypothesis is neglected as useless, it is needless to examine the arguments for or against it.

Except where muscles, cartilages, or ligaments, are inserted into the *periosteum*, its external surface is connected to the surrounding parts by thin cellular membranes, which can easily be stretched considerably, but shorten themselves whenever the stretching force is removed. When these membranes are cut off or broken, they collapse into such a small space, that the surface of the *periosteum* seems smooth and equal.

When we attempt to tear off the *periosteum* from bones, we see a great number of white threads produced from the membrane into them; and, after a successful injection of the arteries with a red liquor, numerous vessels are not only seen on the *periosteum* (*b*), but most of the fibres seat from the membrane to the bone, shew themselves to be vessels entering it, with the injected liquor in them; and when they are broken, by tearing off the *periosteum*, the

(*a*) Havers Osteolog. nov. disc. I. p. 16.

(*b*) Ruyisch. epist. 5. tab. 5. fig. 1, 2; epist. 8. tab. 9. fig. 1, 9.

the surface of the bone is almost covered with red points.

The veins corresponding to these arteries are sometimes to be seen in subjects that die with their vessels full of blood; though such numerous ramifications of them, as of the arteries, can seldom be demonstrated, because few of them naturally contain coloured liquors, and such liquors can difficultly be injected into them. This, however, is sometimes done (a).

The great sensibility of the *periosteum* in the deep-seated species of *paronychia*, in *exostoses*, *nodi*, *tophi*, and *gummata*, from a *lues venerea*, or whenever this membrane is in an inflamed state, is a sufficient proof that it is well provided with nerves, though they are perhaps too small to be traced upon it; and therefore, one cannot well determine, whether they are sent along with the arteries in the common way, or are derived from the tendinous fibres of the muscles expanded on the *periosteum* (b).

Vessels also pass through the *periosteum* to the marrow; of which more hereafter. And frequently muscles, ligaments, or cartilages, pierce through the *periosteum*, to be inserted into the bones.

The chief uses of the *periosteum* are, 1. To allow the muscles, when they contract or are stretched, to move and slide easily upon the bones; the smooth surface of this membrane preventing any ill effects of their friction upon each other. 2. To keep in due order, and to support the vessels in their passage to the bones. 3. By being firmly braced on the bones, to assist in setting limits to their increase, and to check their overgrowth. 4. To strengthen the conjunction of the bones with their *epiphyses*, ligaments, and cartilages, which are easily separated

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(a) See traité d'ostéologie, traduit de l'Anglois de Mr. Monro. Note in page 9.

(b) See the dispute about the sensibility of this and of other membranes in Zimmerman. Dissert. de irritabilit.—Act. Gotting. vol. 2.—Haller sur la nature sensible et irritable.—Whytt's physiolog. essay 11.—Remar. dissert. de fungo articulor. § 26. 34.

4 OF THE BONES IN GENERAL.

in young creatures, when this membrane is taken away. 5. To afford convenient origin and insertion to several muscles which are fixed to this membrane. And, *lastly*, To warn us when any injury is offered to the parts it covers ; which, being insensible, might otherwise be destroyed without our knowledge, or endeavouring to procure a remedy.

When the cellular substance connecting the *periosteum* to the surrounding parts is destroyed, these parts are fixed to that membrane, and lose the sliding motion they had upon it ; as we see daily in issues, or any other tedious suppurations near a bone.— When the vessels which go from the *periosteum* to the bones are broken or eroded, a collection of liquor is made between them, which produces a horrid ulcer or rotten bone. This often is the case after fractures of bones, and inflammations of the *periosteum*, or after *small pox*, *measles*, *spotted fevers*, and *erysipelas*.—Do not the disorders of the *periosteum*, coming rather along with, or soon after the cutaneous than other diseases, indicate some similarity of structure in the *periosteum* and skin ?

The BONES are the most hard and solid parts of the body, and, as all other parts where large vessels do not enter, are generally of a white colour ; only in a living creature they are blueish, which is owing to the blood in the small vessels under their surface. The less, therefore, and fewer the vessels are, and the thicker and firmer the bony surface covering the vessels is, the bones are whiter. Hence the bones of adults are whiter than those of children ; and, in both young and old, the white colour of different bones, or of the several parts of the same bone, is always in proportion to their vessels and solidities ; which circumstances ought to be regarded by surgeons, when they are to judge of the condition of bones laid bare.

Bones are composed of a great many *plates* *, each of which is made up of fibres or strings united by smaller

* *Squamæ, bractæ, laminae.*

smaller fibrils (*a*) ; which being irregularly disposed, and interwoven with the other larger fibres, make a reticular work.—This texture is plainly seen in the bones of foetuses, which have not their parts closely compacted, and in the bones of adults which have been burnt, long exposed to the weather, or whose composition has been made loose by diseases.—The chinks which are generally made, according to the direction of the larger fibres of bones that have undergone the action of fire, or of the weather, shew the greater strength of these than of the fibres which connect them.—Numerous accurate observations of the different times in which exfoliations are made from the sides or ends of similar bones, might bid fair to determine what is the proportional force of cohesion in the two sorts of fibres.

The plates are said (*b*) to be firmly joined to each other by a great number of *claviculi*, or small bony processes, which, rising from the inner plates, pierce through some, and are fixed into the more external ones. Of these nails four kinds, *viz.* the *perpendicular*, *oblique*, *headed*, and *crooked*, have been described: But in bones fitly prepared, I could only see numerous irregular processes rising out from the plates (*c*).

Though the exterior part of bones is composed of firm compact plates, yet they are all more or less cavernous internally. In some (*e. g.* middle thin part of the *scapula* and *os ilium*) the solid sides are brought so near, that little cavity can be seen; and in others (middle of *os humeri*, *femoris*, &c.) the cavities are so large, that such bones are generally esteemed to be hollow or fistular. But the internal spongy texture is evident in young animals; and some of it may be seen to remain in those of greatest age, when bones are cautiously opened after they have been kept so long as to be free of the oil they contain, or after being burnt.

(*a*) Malpigh. Anat. plant. et oper. posth.

(*b*) Gagliard. Anat. ossium, nov. invent. illustrat. cap. 1. obs. 2.

(*c*) Malpigh. oper. posthum.

6 OF THE BONES IN GENERAL.

This spongy cavernous internal part of bones, is generally called their *cancelli* or LATTICE-WORK, and is formed in the following manner. The plates are firmly joined about the middle of the bone: but as they are extended towards its ends, the more internal plates separate from the exterior, and stretch out their fibres towards the axis of the bone, where they are interwoven with the fibres of other plates that have been sent off in the same way. Seeing the plates are thus constantly going off, the solid sides of the bones must become thinner, and the lattice-work must be thicker and stronger towards their ends. This is evident in many of them, where the solid sides of their middle are very thick, and the *cancelli* are scarce observable; whereas, at the ends, where their diameter is greatest, the solid walls or sides are not thicker than paper; and the *cancelli* are numerous and large enough to fill up the whole space left between the sides.

The twisting and windings which these *cancelli* make, and the interstices which they leave, differ considerably in figure, number, and size; and therefore form little cells, which are as different, but communicate with each other. Some writers (a) minutely remark these different appearances of the *cancelli*, after they begin to separate from the plates; and from thence distinguish them into *wrinkled*, *perforated*, and *net-like*.

The *cancelli* sustain the membranous bags of the marrow which are stretched upon them, and thereby hinder these membranous parts to be torn or removed out of their proper places, in the violent motions and different postures which the bones are employed in. This support which the *cancelli* afford the marrow, also saves its membranes and vessels, in the lower parts of the bones, from being compressed by the weight of the marrow above.

The depressions between the fibres of the external plates of bones appear like so many furrows on their surface,

(a) Gagliar, Anat. ossium, cap. I. obs. 4, 5, 6, 7.

OF THE BONES IN GENERAL. 7

surface, into each of which the *periosteum* enters; by which the surface of contact, consequently the cohesion, between it and the bone, is considerably increased, and a greater number of vessels is sent from it into the bone, than if it was a plain surface.

Both on the ridges and furrows, numerous little pits or orifices of canals are to be seen, by which the vessels pass to and from the bones.

After a successful injection, the arteries can be traced in their course from the pits to the plates and fibres; and, in sawing, cutting, or rasping the bones of living creatures, these vessels discover themselves, by the small drops of blood which then ooze out from the most solid part of the bones. But the clearest demonstration of the intimate distribution of these small arteries, is, to observe the effect of such a tinging substance as can retain its colour, when swallowed, digested, and mixed with the blood of any living animal, and at the same time has particles small enough to be conveyed into the vessels of the bones; such is *rubia tinctorum*, madder root (a): For we see the gradual advances which this tincture makes from the *periosteum* into the more internal parts of the bones, and how universally the distribution of the liquors is made, the whole bony substance being tinged. Whether the time in which this tinged liquor passes from the outer to the internal plates, till all the plates are made of its colour, and the time which the disappearing of the dye, after giving the creature no more of this sort of food, makes us think it takes to return, are the same in which the natural liquors circulate, is uncertain; because this tinging substance may move more slowly, or may pass more quickly, than the natural liquors do.—The arteries are larger near each end than at the middle of the large bones that are much moved; because they not only serve the bony plates near the ends, but pass through them to the marrow.—As animals advance

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(a) *Philosop. transact.* Num. 442. art. 8. Num. 443. art. 2.
Num. 457. art. 4.—*Mém. de l'Acad. des sciences*, 1739, 1742.

8 OF THE BONES IN GENERAL.

in age, the arteries of the bones become less capacious; as is evident, 1. From the bones of adults having less blood in them than those of children have. 2. From many of them becoming incapable in old age of admitting the coloured powders used in injections, which easily pass in youth. And, 3. From the bones of old creatures being more difficultly tinged with madder than those of young ones.—If authors have not mistaken, the arteries of bones have sometimes become very large (*a*).

We may conclude from arteries being accompanied with veins so far as we can trace them in every other part of the body, that there are also veins in the bones; and the disappearing of the tincture of *madder*, after bones of living animals are coloured with it, could not be without such veins to carry it away; nay, the veins of bones can sometimes be injected, and then seen (*b*).

The bones of a living animal are so insensible, that they can be cut, rasped, or burnt, without putting the creature to pain, and the nerves distributed in their substance cannot be shewn by dissection; from which it might be inferred that they have no nerves distributed to them: But the general tenor of nature, which bestows nerves to all the other parts, should prevent our drawing such a conclusion. And if sensibility is a sure proof of nerves entering into the composition of any part, as it is generally allowed to be, we have sufficient evidence of nerves here in the bones; for the granulated red flesh which sprouts out from them, after an amputation of a limb, or performing the operation of the *trepan*, or after an *exfoliation*, is exquisitely sensible: And, in some ulcers of bones, where the *periosteum* was all separated, the patient suffered racking pain, if the bone was touched with a rough instrument; nor was he free of pain after the bone was perforated (*a*)—The reason why

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(*a*) Diemerbroek Anat. lib. 9. cap. 1.—Mery. Hist. de l'Acad. des sciences, 1704.

(*b*) Sue trad. d'osteolog. p. 9.

(*c*) Nicol. Massa lib. introd. anat. cap. 30.

the nerves of rigid hard bones become insensible, is, That all nerves must have a considerable degree of flexibility at the part where objects are applied, otherwise it cannot be affected by their impressions. We see this illustrated in a very common analogous case, the growth of a new nail: When the former one has suppurated off, the thin membrane which first appears, is exquisitely sensible; but gradually becomes dull in its sensation, till it can be cut or scraped, without causing pain, after it is formed into a hard nail.

From what has been said of the vessels of bones, it is evident, that there is a constant circulation of fluids in every part of them; and that there is a perpetual waste and renewal of the particles which compose the solid fibres of bones, as well as of other parts of the body; the addition from the fluids exceeding the waste during the growth of the bones; the renewal and waste keeping pretty near *par* in adult middle age; and the waste exceeding the supply from the liquors in old age; as is demonstrable from their weight: For each bone increases in weight, as a person approaches to maturity; continues of nearly the same weight till old age begins, and then becomes lighter.—The specific gravity of the solid sides, on the contrary, increases by age; for then they become more hard, compact, and dense. In consequence of this, the bones of old people are thinner and firmer in their sides, and have larger cavities than those of young persons.

The vascular texture of bones must make them subject to *obstructions*, *ecchymoses*, *ulcers*, *gangrenes*, and most other diseases which the softer parts are affected with; and therefore there may be a greater variety of *caries* than is commonly described (*a*).

Hence we can account for the following appearances.

Hemorrhagies from fungous flesh rising out from the most solid part of a cut bone (*b*).

The

(*a*) Edinburgh Medical essays and obs. vol. 5. art. 25.

(*b*) Medical essays, vol. 4. art. 21.

The regular alternate elevation and subsiding, or apparent pulsation, frequently to be seen in some of the cells of a carious bone.

Cells resembling *cancelli*, sometimes seen in the part of a bone, which, in a natural state, is the most solid and firm (c).

* A bone as a tube including another bone within it (d).

On the internal surface of the solid parts of bones, there are orifices of canals, which pass outwards through the plates to open into other canals that are in a longitudinal direction, from which other *transverse* passages go out to terminate in other *longitudinal* canals; and this structure is continued through the whole substance of bones, both these kinds of canals becoming smaller gradually as they approach the outer surface (a).—These canals are to be seen to the best advantage in a bone burnt till it is white: When it is broken transversely, the orifices of the *longitudinal* canals are in view; and when we separate the plates, the *transverse* ones are to be observed. Here however we are in danger of believing both these sorts of canals more numerous than they really are; because the holes made by the processes connecting the plates of bones, have the appearance of the *transverse* (b), and the passages for the blood-vessels resemble the *longitudinal* canals. I do not know how we are to keep free of error about the *transverse* canals; but think we may distinguish between the two kinds of *longitudinal* ones; for the passages of the vessels are largest near the external surface of the bone, and every transverse section of them is circular; whereas the *longitudinal* canals are largest near the *cancelli*, and their transverse sections appear to me of a flat oval figure, which may be owing to the different *momentum* of the fluids conveyed in them.—The situation of the larger longitudinal canals, and of the passages of the larger vessels,

(c) Ruysh. Thes. 8. num. 8. Thes. 10. num. 276.

(d) Idem, ibid.

(a) Havers Osteolog. nov. p. 43.

(b) Morgagni. Advers. 2. animad. 25.

vessels, makes a bone appear more dense and compact in the middle of its solid sides, than towards its outer and inner surfaces, where it is spongy.

We see marrow contained in the larger transverse and longitudinal canals just now described, and from thence judge that it passes also into the smaller ones. The drops of oil which we discover with a microscope every where on the surface of a recent bone, fractured transversely, and the oozing of oil through the most solid bones of a skeleton, which renders them greasy and yellow, are a confirmation of the use of these canals. Of what advantage this distribution of the marrow through the substance of bones is, will be mentioned when the nature and use of this animal oil is inquired into.

Most bones have one or more large oblique canals formed through their sides for the passage of the medullary vessels, which are to be described afterwards.

Bones exposed to a strong fire in chemical vessels, are resolved, in the same manner as the other parts of animals, into *phlegm*, *spirit*, *volatile salt*, *fetid oil*, and a black *caput mortuum*. But the proportion of these principles varies according to the age, solidities, and other circumstances of bones. Young bones yield the largest proportion of *phlegm*; spongy bones afford most *oil*, and solid ones give most salt and black *residuum*.—Though this *residuum* can scarce be changed by the force of fire while it is in close vessels; yet, when it is burnt in an open fire, the tenacious oil, to which it owes its black colour, is forced away, and a white earth is left that has little or no fixed salt in it. This earth seems to be the proper constituent solid part of bones, and the other principles give it firmness and tenacity: For the quantity of the earth is so great, that, after all the other principles are separated from a bone, its former shape and size remain (a); but it is very brittle till it is moistened with water or oil, when it recovers some tenacity.—The increase of the proportion of earth in old people's

(a) Havers Osteolog. nov. disc. I. p. 32.

people's bones is one reason of their being more brittle than those of young people are.

Lest any imagine the salts and oils of bones, while in a natural state, to be of the same acrid kind with those obtained from them by the chemical analysis, it is to be observed, that these principles may be extracted from bones in the form of a very mild jelly, by boiling them in water.

The bones sustain and defend the other parts of the body.

Bones are lined within, as well as covered externally, with a membrane; which is therefore commonly called PERIOSTEUM INTERNUM.

The *internal periosteum* is an extremely fine membrane; nay, frequently it has a loose reticular texture; and therefore it is compared by some to the *arachnoid* coat of the spinal marrow: so that we cannot expect to divide it into layers as we can divide the *external periosteum*. We can however observe its processes entering into the transverse pores of the bones, where probably they are continued to form the immediate canals for the marrow distributed through the substance of the bones; and along with them vessels are sent, as from the external *periosteum*, into the bone (b). These processes being of a very delicate texture, the adhesion of this membrane to the bone is so small, that it separates commonly more easily from the bone than from the marrow which it contains: Wherefore, one might call it the common membrane of the marrow, rather than by the name it now has. But whether the one or the other designation ought to be given it, is not worthy a dispute.

From the internal surface of the *internal periosteum*, a great number of thin membranes are produced; which, passing across the cavity, unite with others of the same kind, and form so many distinct bags, which communicate with each other; and these again are subdivided into communicating vesicular cells, in which the marrow is contained. Hence it is,

(b) Winslow Exposition anat. des os frais, § 82. 83.

is, that the marrow, when hardened, and viewed with a microscope, appears like a cluster of small pearl; and that the hardened marrow of bones buried long under ground, or laid some time in water, and then dried, is granulous (*a*). This texture is much the same with what obtains in the other cellular parts of the body, where fat is collected; only that the cells containing the marrow are smaller than those of the *tunica adiposa* or *cellulosa* elsewhere, which probably is owing to their being inclosed in the bones, where they are not so much stretched or extended as in other parts.

The MARROW is the oily part of the blood, separated by small arteries, and depositated in these cells. Its colour and consistence may therefore vary according to the state of the vessels, and their distribution on the membranes of the cells.

The marrow, as well as the other fat of the body chemically analysed, yields, besides oil and water, a considerable proportion of an acid liquor, but no *alcali* (*b*). This may be the reason of its being less putrescent than the blood or most other parts of animals (*c*), which is a necessary quality in a substance that is constantly exposed to a considerable degree of heat, and is more in a stagnating condition than the other liquors.

Besides the arteries, which I mentioned already (p. 7.), to be sent from the bones to the marrow, there is at least one artery for each bone; several bones have more, whose principal use is to convey and discern this oily matter. After these arteries have pierced the solid side of a bone, they are divided into several branches; which soon are distributed every where on the internal *periosteum*, and afterwards spread their branches inwards on the medullary cells, and outwards through the tables of the bone.

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The

(*a*) Ruysch. Thesaur. 9. num. 2. et Advers. dec. III. obs. 9.

(*b*) Grutzmaker Dissert. de ossium medulla.—Haller Element. physiolog. lib. 4. sect. 4.

(*c*) Pringle Append. to camp diseases, exper. 47.

The blood which remains after the secretion of the marrow, is returned by proper veins, which are collected from the membranes into one or two large trunks, to pass out at the same holes or passages at which the artery or arteries enter.

The general rule of the small vessels decreasing in their capacities as animals advance in age, to which many phænomena in the animal œconomy are owing, obtains here: For though the trunks of the medullary vessels enlarge as animals turn older; yet the small branches become smaller; as is evident from injections, which cannot be made to pass near so far in these vessels of adults as of children. Hence the marrow is bloody in children, oily and balmy in middle age, and thin and watery in old people.

By experiments made on the marrow, when bones of living animals are opened or cut through (*a*), and from the racking pain with which suppurations within bones are frequently attended, we have sufficient proof that the membranes here are sensible, and consequently have nerves distributed to them. *Hippocrates* (*b*) might therefore say justly, that a wound penetrating into the cavity of a bone may produce a *delirium*.

The vessels of the marrow, wrapt up in one common coat from the *periosteum*, pass through the bones by proper canals; the most considerable of which are about the middle of each bone, and are very oblique. Sometimes these vessels continue at a little distance in their passage when the canal is divided by a small bony partition or two.

From the structure of the contents of the bones, we may judge how these parts, as well as others, may be subject to oidema, phlegmon, erysipelas, schirrhus, &c. and may thence be led to a cure of each, before the common consequence, putrefaction, takes place, and frequently occasions the loss of the limb, if not of the patient.

The

(*a*) *Du Verney Memoires de l'Acad. des sciences, 1700.*

(*b*) *Aphorism. § 7. aph. 24.*

The marrow is of very considerable use to the bones; for, by entering their transverse canals, and passing from them into the longitudinal ones, it is communicated to all the plates, to soften and connect their fibres, whereby they are preserved from becoming too brittle; as we see they do in burnt bones, or those long exposed to the air; in people labouring under old age, pox, or scurvy: In all which cases, the oil is either in too little quantity, or has its natural good qualities changed for worse ones.

Besides this advantage which the substance of bones has from the marrow, their articulations are said (*a*) to receive no less benefit from it: for it is thought that the marrow passes into the articular cavities, through the holes which are in the bones near the large joints. And, as a proof of this, it is alledged, that butchers, upon seeing the greater or lesser quantity of marrow, in the bones of cows, can tell whether they have travelled far or little before they were slaughtered.

When the marrow, after having served the uses mentioned, is reassumed into the mass of blood, (as it is continually, in common with all other secreted liquors that have not passages formed for conveying them out of the body), it corrects the too great acrimony communicated to the saline particles of our fluids by their circulation and heat; in the same manner as lixivial salts are blunted by oil in making soap. Hence, in acute diseases, the marrow, as well as the other fat of the body, is quickly wasted, but must be immediately supplied by liquors from the vessels; seeing the cells within the bones, which have no assistance to their contraction from the pressure of the atmosphere, cannot collapse, as the *tela cellularis* under the skin does, when the liquor in its cells is absorbed; the bones therefore are always full.

Since it is the nature of all oil to become thin and rancid when exposed long to heat, and bones have

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much

(*a*) Joan de Muralto Vade mecum anat. exercit. 5. § 3.—Havers Osteolog. nov. dicit. 3. p. 179.

much oil in their firm hard substance, we may know why an ungrateful smell, and dark coloured thin *ichor*, proceed more from corrupted bones than from other parts of the body; and we can understand the reason of the changes of colour which bones undergo, according to their different degrees of mortification.— Hence likewise we may learn the cause of a *spina ventosa*, and of the difficulty of curing all *caries* of bones proceeding from an obstruction, and consequent putrefaction of the marrow; and of the quick pulse, thirst, and *hectic paroxysms*, so often attending these diseases. These *phænomena* also teach us the reason of the fatal *prognosis* taken from black fetid urine in fevers.

Though bones so far agree in their structure and annexed parts, yet we may observe a considerable difference among them in their magnitude, figure, situation, substance, connection, uses, &c. From which authors have taken occasion to distinguish them into as many classes as they could enumerate of these different circumstances. But these being obvious to every person that looks on bones, I shall only mention one of them; which comprehends very near the whole bones of the body, and at the same time leads us to examine the most considerable variety that is to be found in the disposition of their constituent parts, and in their uses. It is this, that some bones are *broad* and *flat*, while others are *long* and *round*.

The *broad* bones have thin sides, by the plates being soon and equally sent off to form the lattice-work; which therefore is thicker, and nearly of an equal form all through. By this structure, they are well adapted to their uses, of affording a large enough surface for the muscles to rise from, and move upon, and of defending sufficiently the parts which they inclose.

The *round* bones have thick strong walls in the middle, and become very thin towards their ends, which is owing to very few plates separating at their middle; where, on that account, the *cancelli* are so fine and

and small, that they are not taken notice of: But such bones are said to have a large reservoir of oil in this place. Towards their ends the lattice-work becomes very thick, and rather more complete than in the other sort of bones.—These round bones having strong forces naturally applied to them, and being otherwise exposed to violent injuries, have need of a cylindrical figure to resist external pressure, and of a considerable quantity of oil to preserve them from becoming too brittle. Besides which, they are advantageously provided with thick sides towards their middle, where the greatest forces are applied to injure them; while their hollowness increases their diameter, and consequently their strength to resist forces applied to break them transversely (*a*). Thus, for instance, in estimating the proportional resistance of two cylindrical bones of unequal diameters, but consisting of an equal number of similar fibres uniformly disposed round each, it is plain,

1. That the absolute force of these two bones is equal, because they consist of equal numbers of similar fibres.

2. That the absolute forces of all the fibres in each bone have the same effect in resisting any power applied to break them, as if the sum of all their forces was united in the respective centres of the transverse sections where the fractures are to be made. For, by hypothesis, the fibres being uniformly disposed in each, there is not any fibre in either bone that has not a corresponding fibre; the sum of both whose distances from the axis of revolution (about which all the parts of the bone must revolve in breaking), is equal to two semidiameters of the bone; Consequently each fibre, and all the fibres, may be regarded as resisting at the distance of one semidiameter or *radius* from this axis, that is, in the centre.

3. Since the united force of all the fibres is to be regarded as resisting at a distance from the centre of motion equal to the semidiameter, it follows, that

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the

(*a*). Galilei Mechanic. dialog. 2.

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the total resistance of all these fibres, or the strength of the bone, is proportional to its semidiameter, and consequently to its diameter.

I have here taken for an example one of the most simple cases for calculating the proportional forces of bones. But, was it not too foreign to the present design, it might be universally demonstrated, that, of whatever figure bones are, and in whatever manner their fibres are disposed, their strength must always be in a *ratio*, compounded of the area of their transverse sections, or of their quantity of bony matter, and of the distance of the centre of gravity of these sections from the centre of motion or fulcrum, on which the bone is supposed to be broken (*a*).

Since therefore the strength of bones depends on their number of fibres, or quantity of matter, and the largeness of their diameters, one may conclude, that the part of a bone formerly fractured, and re-united by a *callus*, must be stronger than it was before the fracture happened; because both these advantages are obtained by a *callus*; which is a wise provision, since bones are never set in such a good direction as they were naturally of; and then, wherever a *callus* is formed, there is such an obstruction of the vessels, that if the bone was again broken in the same place, the *effuse* matter could not so easily be conveyed to reunite it. This *callus* may indeed, for want of compression, be allowed to form into a spongy cellular substance (*b*); but even in this case, the strength of the bone is here increased by one or both the causes above-mentioned.

Many bones have protuberances, or *processes* *, rising out from them. If a *process* stands out in a roundish ball, it is called *caput*, or *head*.—If the head is flattened, it obtains the appellation of *condyle*.—A rough unequal protuberance,

(*a*) See the demonstration of this theorem by Dr Porterfield in the Edinburgh Medical essays, vol. I. art. 10.

(*b*) Ruysch. Thesaur. 8. n. 49. Mus. anat. thec. B. reposit. 2. n. 2.

* Ανθόστης, ἔφυστης, ἵξοχη, προβολὴ, προβλῆμα, Excessus, explanatio, tuberculum, gibbus, eminentia, productio, extuberantia, projectura, enascentia.

protuberance, is called *tuberosity*.—When a *process* rises narrow, and then becomes large, the narrow or small part is named *cervix*, or *neck*.—Long ridges of bones, are called *spines*.—Such processes as terminate in a sharp point, have the general name of *coronæ* †, or *coronoid*, bestowed on them, though most of them receive particular names from the resemblance they have, or are imagined to have, to other substances, e. g. *mastoid*, *styloid*, *anchoroid*, *coracoid*, *spinal*, &c.—Such processes as form brims of cavities, are called *supercilia* (a).

Processes serve for the advantageous origin and insertion of muscles, and render the articulations firm and stable.

Before leaving this subject, we must remark, that much the greater number of what are called processes in adult bones, discover themselves in children to be *epiphyses*, or distinct bones, which are afterwards united to the other parts; such are the *styloid* processes of the temporal bones, processes of the *vertebrae*, *trochanters* of the thigh, &c. However, as I design to insist chiefly on the description of the adult skeleton, in which the union of these parts is so intimate, that scarce any vestige remains of their former separation, I shall retain the common appellation of *apophysis*, or process, to all such protuberances; but shall remark the principal ones, that have no just title to this name, when they occur in the description of particular bones.

On the surfaces of a great many of the bones there are cavities, or depressions: If these are deep, with large brims, authors name them *cotyla* (b).—If they are superficial, they obtain the designation of *glenæ*, or *glenoid*. These general *classes* are again divided into several *species*:—Of which *pits* are small roundish channels sunk perpendicularly into the bone;—*furrows* are long narrow canals, formed in the surface;—*niches*, or *notches*, small breaches in the bone;—

sinugisties.

† *Rostra*, *glandes*.

(a) Ττυες, ὄφυες, ἀμύονες, χειλη, *Labra*.

(b) Κοτυλίδες, ὀξυβάροι, *Acetabula*, *pixides*, *buccellæ*.

sinuosities, broad, but superficial depressions without brims;—*fossæ*, large deep cavities, which are not equally surrounded by high brims;—*sinuses*, large cavities within the substance of the bones, with small apertures;—*foramina*, or holes, canals that pierce quite through the substance of the bones.—When this last sort of cavity is extended any long way within a bone, the middle part retains the name of *canal*, and its ends are called *holes*.

The cavities allow the heads of bones to play in them; they lodge and defend other parts; they afford safe passage to vessels, muscles, &c. To mention more, would engage us too much in the history of particular bones, which more properly belongs to the demonstration of the *skeleton*, where we shall have occasion to observe these several species of cavities.

To far the greater number of bones, whose ends are not joined to other bones by an immovable articulation, there are smaller ones annexed, which afterwards become scarce distinguishable from the substance of the bone itself. These are called *epiphyses*, or *appendices* (c). Some bones have one, others have two, three, or four of these *appendices* annexed, by the means of cartilages, which are of a considerable thickness in children, but by age become thinner; the ossification proceeding from the end of the bone on one side, and from the *epiphyses* on the other, till at last, in adults, the place of their conjunction can scarcely be seen on the external surface; and it is only sometimes that we can then see any mark of distinction in the *cancelli* (d).

Several processes (e. g. *trochanters* of the thigh, *spine* of the *scapula*, &c.) have *epiphyses*; and processes frequently rise out from *epiphyses*; for example, at the lower end of the *femur*, *ulna*, *tibia*, &c. (e).

The *epiphyses* are united chiefly to such bones as are destined for frequent and violent motion; and for this

(c) *Applantatio, additamentum, adnascientia, adnexum, perone.*

(d) Winslow Exposition anatomique de corps humain, traité des os sœs, § 116.

(e) Vesal. De human. corp. fabrica, lib. I, cap. 3.

this purpose they are wisely framed of a larger diameter than the bone they belong to; for by this means, the surface of contact between the two bones of any articulation being increased, their conjunction becomes firmer, and the muscles inserted into them act with greater force, by reason of their axes being further removed from the centre of motion. These advantages might indeed have been obtained by the expansion of the end of the bone itself, to a thickness equal to that of the *epiphyses*; but then the constant separation of new plates to form so wide a cellular structure, must have left the solid sides of the bones so thin, as to yield easily, either to the action of the muscles fixed to them, and passing over them, to the weight several of them are obliged to support, or to the application of any other external force.

Several anatomists (*f*) thought that the *epiphyses* serve other purposes: such as, securing the ligaments of the articulations which rise out from between the bones and them; for, as soon as these parts are intimately joined, the ligaments insinuated betwixt them must have a much stronger connection than they could have to the smooth surface of the bones. Such an intercession of the ligament between the body of the bone and its *epiphysis* is not to be seen; but as, at this place, the bone remains longer soft than any where else, and the adhesion of the *periosteum*, and of ligaments to bones, is always stronger in proportion to the bones being nearest to the consistence of those parts, which is, being softest, the opinion of these writers concerning the stronger connection of the ligaments, where the bones and *epiphyses* join, is not without some foundation.

Possibly, too, by the fibres of *epiphyses* not extending themselves so longitudinally as those of the bones, there may be less chance of the former running into each other, than of the latter.

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(*f*) Collumb. De re anatomica, lib. I. cap. 2.—Fallop. Expositio ossibus, cap. II.

The softness of the ends of bones may be of some advantage in the womb, and at birth, after which the ossification begins at different points to form *epiphyses*, before the ossification can extend from the middle to the ends of the bones (g).

However solid and compact adult bones are, yet they were once cartilages, membranes, nay, a mere jelly. This needs no further proof, than repeated observations of *embryos* when dissected: And how much more tender must the bones be before that time, when neither knife nor eye is capable to discover the least rudiments of them? By degrees they become more solid, then assume the nature of gristles, and at last ossify; the cohesion of their plates and fibres always increasing in proportion to their increased solidities; as is evident from the time necessary to unravel the texture of bones of people of different ages, or of dense and of spongy bones, or of the different parts of the same bone, and from the more tedious exfoliations of the bones of adults than of children.

After any part of a bone is fully ossified, its fibres are extended little more in length at that part, though they increase there in thickness, and though their softer parts continue to become longer (b).

As the solidity of bones increases, their *periosteum* more easily separates from them. When bones are membranous, the *periosteum* and they cannot be distinguished; they appear to be the same substance. When they are cartilages, their membrane adhere so firmly to them, that it is difficult to separate it from them. Where the rigid bony fibres are, the *periosteum* is easily taken off. Is the similarity of structure and consequent greater attraction of the membrane and substance it incloses, while they are both flexible, the cause of their greater adhesion? or is it owing to the vessels that go from the one to the other being

(g) Haller de studio medic. p. 267.

(h) Hales's Vegetable statics, p. 293.—Du Hamel Memoires de l'acad. des sciences, 1742.

ing then larger? or do both these causes combine to produce this effect? Or is the membrane or cartilage, which becomes bone afterwards, to be considered as the same substance with the *periosteum* (*i*)? and must all these plates of bones be therefore said to be layers of the *periosteum* hardened (*k*)?

The ossification of bones depends principally on their vessels being so disposed, and of such diameters, as to separate a liquor, which may easily turn into a bony substance, when it is deprived of its thinner parts; as seems plain from the observation of the callous matter separated after fractures and ulcers, where part of the bone is taken out: For in these cases, the vessels extending themselves, and the liquors added to them, are gradually formed into granulated flesh; which fills up all the space where the bone is taken from, then hardens, till it becomes as firm as any other part of the bone. This happens frequently, even when the ends of the diseased bone are at a considerable distance from each other (*l*).

The induration of bones is also greatly assisted by their being exposed, more than any other parts, to the strong pressure of the great weights they support, to the violent contraction of the muscles fixed to them, and to the force of the parts they contain, which endeavour to make way for their own further growth. By all this pressing force, the solid fibres and vessels of bones are thrust closer; and such particles of the fluids conveyed in these vessels as are fit to be united to the fibres, are sooner and more firmly incorporated with them, while the remaining fluids are forcibly driven out by the veins, to be mixed with the mass of blood. In consequence of this, the vessels gradually diminish as the bones harden. From which again we can understand one reason, why the bones of young animals sooner reunite after a fracture than those

(*i*) *Memoires de l'acad. des sciences*, 1744.

(*k*) *Memoires de l'acad. des sciences*, 1743.

(*l*) Hildan, de vuln. gravis.—Med. essays, vol. I. art. 23.—Job à Meckren obs. 69.—Mem. de l'acad. des sciences, 1742.—See a collection of such cases in Bochmer de ossium callo.

those of old, and why cattle that are put too soon to hard labour seldom are of such large size as others of the same brood who are longer kept from labour.

That the ossifying of bones greatly depends on pressure, seems to be evinced from the frequent examples we meet with of other parts turning bony, when long exposed to the pressing force of the surrounding parts, or when they are subjected to the like circumstances by their own frequent and violent contraction. Witness, the bones found frequently near the base of the heart in some old men (*m*), and in several other creatures. Nay, the muscular substance of the heart has been ossified in such (*n*), and the arteries of old men often become bony.—The cartilages of the *larynx* are generally ossified in adults.—In beasts of burden, the cartilages between the *vertebræ* of the back very often change into complete bones; and, being intimately united with the *vertebræ*, the whole appears one continued bone:—Nor is the *periosteum* exempted from such an induration (*o*).

To confirm this argument still farther, we may observe, that bones begin their ossification at the places where they are most exposed to these causes, *viz.* in the cylindrical bones from a middle ring, and in the broad ones, at or near their centre, from one or more distinct points. The reason of which is, that these parts are contiguous to the bellies of the muscles annexed to the bones, where the swelling of these moving powers is greatest. What the effects of this may be, let any judge, who view some of the bones, as the *scapula*, and *osseum ilium*, which are covered with muscles on each side; how compact and thin they are in adults, where the bellies of the muscles were lodged; whereas in children they are thicker. But this being the middle part of these bones,

(*m*) Riolan. Comment. de ossib. cap. 32.—Bartholin. Hist. med. cent. 1. hist. 50.—Ibid. cent. 2. hist. 45.

(*n*) Cheselden's Anatomy, book 1. introd.—Garengeot Hist. de l'acad. des sciences, 1726.

(*o*) Peyer. Ephemerid. German. decur. 2. ann. 7. observ. 205.

bones, where the greatest number of fibres is, this particular place would have been much thicker in adults, had not this forcible cause been applied, which has not had such effects in children, whose muscles have not been much exercised.—Besides, if we allow that all the parts of a bone are equally increased by the constant supply of new particles, each fibre, and every particle of a fibre, endeavours to make way for its own growth, by pushing the one next to it; and consequently by far the greatest pressure is on the middle, to make the particles firm, and therefore to begin their ossification there. *Lastly,* The pulsation of the medullary arteries, which enter the bones near to this middle part, may, as authors have alledged, contribute perhaps somewhat to this induration.

From the effects of pressure only it is, that we can account for the bones of old people having their sides much thinner, yet more dense and solid, while the cavities are much larger than in those of young people; and for the prints of muscles, vessels, &c. being so much more strongly marked on the surfaces of the former than of the latter, if they belong to people of near the same condition in life.—Pressure must likewise be the cause which, in people of equal ages, makes these prints stronger in the bones of those who had much labour and exercise, than they are in people who have led an indolent inactive life.

Perhaps both the causes of ossification above mentioned, may be assisted by the nature of the climate people live in, and the food they use. Whence, in hot countries, the inhabitants sooner come to their height of stature than in the northerly cold regions: And thence seems to have arisen the common practice among the ladies, of making puppies drink brandy or spirit of wine, and of bathing them in these liquors, to prevent their growing big. Nay, it has been observed, that much use of such spirits has occasioned parts, naturally soft, to petrify in some, and to ossify in other people of no great age (*p.*).

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From

(*p.*) Littre Histoire de l'acad. des sciences, 1706.—Geoffroy Mémoires de l'acad. des sciences, 1706.

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From the foregoing account of the structure of bones, and of their ossification, we may understand the reasons of the following phænomena.

How the natural colour of bones may be changed by some sorts of food (*q*).

Why the bones of some people are so long in hardening, and in others never completely indurate.

Why, in such whose ossification is slow, the bones are generally thicker in proportion to their lengths, especially at their ends; as in the rickets.

How hard firm bones have become soft and pliable by diseases (*r*).

Why in some diseases, *epiphyses* separate from bones (*s*), and the ends of fractured bones come asunder many years after their fractures appeared to be cured (*t*).

How bones may waste and diminish (*u*).

How bones may become solid all through, without any appearance of *cancelli* (*x*).

How *nodes*, *tophi*, and *exostoses*, happen after the erosion of the external plates of bones in the *lues venerea*, *scurvy*, *rheumatism*, and *gout*.

How bones exfoliate by the rising of granulated flesh from their surface.

How, and from what *callus* is formed after a fracture (*y*).

Why

(*q*) Philosoph. Transact. Num. 442. art. 8. Num. 443. art. 2. Num. 457. art. 4.—Mem. de l'acad. des sciences, 1739, 1742.

(*r*) Histoire de l'acad. des sciences, 1700.—Mem. 1722.—Gagliardi Anat. ossium, cap. 2. observ. 3.—Ephem. Germ. decur. I. ann. 1. obs. 37. et sehol. decur. 2. ann. 7. obs. 212, 235. decur. 3. ann. 2. obs. 3.—Philos. Trans. Num. 470. § 3.—Ibid. vol. 40. § 4. and 44.

(*s*) Memoires de l'acad. des sciences, 1699.—Diemerbrock Anat. lib. 9. cap. 19.—Cowper's Anat. explic. tab. 96. fig. I.

(*t*) Anion's Voyage.

(*u*) Cheselden's Anat. book I. introd.—Hist. de l'acad. des sciences, 1700.

(*x*) Ruysch. Thesaur. 2. arc. 5. thes. 3. loc. 1. Num. 5. thes. 9. Num. 2. not. 3.—Bochmer de callo ossium.

(*y*) Memoires de l'acad. des sciences, 1741.—Dichtleef de ossium callo.

Why *callus* appears to be rather the continued substance of the *periosteum* than of the bone, while it remains soft and flexible; but seems continued with the bone after it ossifies (z).

Why *callus* is sensible, while it is soft, but becomes insensible when it hardens.

What occasions sometimes such difficulty in curing fractured bones; or why they never reunite, though they are reduced, and all proper means towards a cure are used (a).—Are the bones of women with child more tedious in reuniting than those of other people (b) ?

Why *calluses*, after fractures, are sometimes very thick and protuberant.

What difference there ought to be in the application of bandages to fractures of the bones of old and of young patients.

How bones, remaining long unreduced after a luxation, may have their form so changed as to make their reduction very difficult, if not impossible (c).

Whoever is desirous to know, in what time and order each bone and its several parts begin to assume a bony nature, let him consult *Kerckingius* (d), who gives us the delineations of abortions from three days after conception, and traces the ossification of the bones from three weeks, and a month, till the time of the birth: To whom should be added *Coiterus* (e) and *Eyffonius* (f). An account of this subject might also be collected out of *Ruyisch's* works, where some of the mistakes committed by the former authors are corrected: And several more parti-

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culars,

(z) Mem. de l'acad. 1741.

(a) Meckren Observ. medico-chirurg. obs. 71.—*Ruyisch. Advers. dec. 2. § 2. observ. anat. chir. obs. 4.*—Van Swieten in Boerhaave Aphor. § 354.

(b) Hildan. centur. 5. obs. 87. et cent. 6. obs. 68.—Philos. Trans. No. 494. § 21.

(c) Saltzman. Obsr. decvr. obsr. 6.—Memoires de l'acad. de chirurg. tom. 2. p. 155.—Bochmer Instit. osteolog. § 596.

(d) Anthropograph. ichnograph. et osteogenea foetuum.

(e) De ossibus foetus abortivi.

(f) De ossibus infant. cognoscend. et curand.

culars, to make the history of the *osteogenea* more accurate; have since been added by *Nebit* (g) and *Albinus* (h).

I must refer to the authors now quoted for the more curious part of the human osteogeny; not having preparations enough to give such a full history of it as is done by them. But I shall endeavour to explain the more useful and necessary part of the osteogeny, by subjoining to the description of each bone of an adult, its condition in ripe children; that is, in such as are born at the ordinary time; and shall point out what parts of each are afterwards joined in form of *epiphyses*. This, with the following general rules, seem to me sufficient for understanding what of this subject is necessary in the practice of physic and surgery.

1. Wherever I mention any parts being cartilaginous, or their being still separable from the other parts of the bone to which they belong, I would be understood to hint, that, about seven or eight years of age, such parts are ossified and united to their proper bones, unless when it is said, that they are afterwards formed into *epiphyses*.

2. Such as become *epiphyses*, are generally ossified at seven or eight years of age; but, being for the most part moistened by *synovia*, their external surface is still somewhat cartilaginous, and they are not yet united to their bones.

3. At eighteen or twenty years of age the *epiphyses* are entirely ossified, and have blended their fibres so with the body of the bone, as to make them inseparable without violence.

The knowledge of this part of the *osteogeny* I think necessary, to prevent dangerous mistakes in the cure of several diseases. As for example: Without this knowledge, the separation of an *epiphysis* might be mistaken for a fracture or luxation.—The interstice of two parts of a bone not yet joined, might be judged to

(g) *Human Osteogeny explained.*

(h) *Icones ossium foetus humani; accedit osteogenes brevis histo-*
ria.

to be a fissure.—A *diastasis*, or separation of such disjoined pieces of a bone, might be thought a fracture.

—The protrusion of one piece, or its overlopping any other, could be mistaken for an excrescence or *exostosis*.—Such errors about the nature of a disease would give one very different indications of cure, from what he would have, if he really understood his patient's case. And very often the knowledge of the different inequalities on the surfaces of bones, must direct us in the execution of what is proper to be done to cure several of their diseases.

Having thus considered the bones when single, we ought next to shew the different manner of their conjunctions †. To express these, anatomists have contrived a great number of technical terms; about the meaning, propriety, and classing of which, there has unluckily been variety of opinions. Some of these terms it is necessary to retain, since they serve to express the various circumstances of the articulations, and to understand the writers on this subject.

The ARTICULATIONS are most commonly divided into three classes, *viz.* *sympysis*, *synarthrosis*, and *diarthrosis*.

Sympysis, which properly signifies the concretion or growing together of parts, when used to express the articulations of bones, does not seem to comprehend, under the meaning generally given to it, any thing relating to the form or motion of the conjoined bones; but by it most authors only denote the bones to be connected by some other substance; and as there are different substances which serve this purpose, therefore they divide it into the three following species :

1. *Synchondrosis* ‡, when a cartilage is the connecting substance: Thus the ribs are joined to the *sternum*; thus the bodies of the *vertebrae* are connected to each other; as are likewise the *osse pubis*.

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2. *Synneurosis*,

† Σύνταξις, σύνδεσις, συμβολή, ἀμφίλεια, compositio, connexio, articulatio, conjunctio, nodus, commissura, structura, compages.

‡ *Amphiarthrosis*.

2. *Synneurosis*, or *syndesmosis*, when ligaments are the connecting bodies, as they are in all the moveable articulations.

3. *Syssarcosis*, when muscles are stretched from one bone to another, as they must be where there are moveable joints.

The second class of articulations, the *synarthrosis*, which is said to be the general term by which the immovable conjunction of bones is expressed, is divided into three kinds.

1. The *suture* † is that articulation where two bones are mutually indented into each other, or as if they were sewed together, and is formed by the fibres of two bones meeting while they are yet flexible and yielding, and have not come to their full extent of growth; so that they mutually force into the interstices of each other, till, meeting with such resistance as they are not able to overcome, they are stopped from sprouting out farther, or are reflected; and therefore these indentations are very different both in figure and magnitude: Thus the bones of the head are joined; thus *epiphyses* are joined to the bones, before their full connection and union with them.

Under this title of *suture*, the *harmonia* of the ancients may be comprehended; scarce any unmoved bones being joined by plain surfaces (a).

2. *Gomphosis* ‡ is the fixing one bone into another, as a nail is fixed in a board: Thus the teeth are secured in their sockets.

3. *Spindylesis* or *ploughing* (d), when a thin *lamella* of one bone is received into a long narrow furrow of another: Thus the *processus azygos* of the *sphenoid*, and the *nasal process* of the *ethmoid* bone, are received by the *vomer*.

The third class, or *diarthrosis* (b), is the articulation where the bones are so loosely connected as to allow

† *Pāgn.*

(a) *Vesal. Observ. Fallop. Examen.*

‡ *Conclavatio.*

(d) *Keil Anat. chap. 5. sect. 3.*

(b) *Απαρθωσις, dearticulatio, abarticulatio.*

low large motion. This is subdivided into three kinds.

The first is *enarthrosis*, or the ball and socket, when a large head is received into a deep cavity; as the head of the *os femoris* is into the *acetabulum coxendicis*.

The second is *arthrodia*, when a round head is received into a superficial cavity; as in the articulation of the arm-bone and *scapula*. These two species of *diarthrois* allow motion to all sides.

The third is *ginglimus* (*c*), which properly signifies the hinge of a door or window; in it the parts of the bones mutually receive and are received, and allow of motion two ways: Workmen call it *charnal*.

The *ginglimus* is generally divided into three kinds, to which some (*d*) give the names of *contiguous* (*e*), *distant* (*f*), and *compound* (*g*).

The first kind of *ginglimus* is, when a bone has several protuberances and cavities, which answer to as many cavities and processes of the other bone, with which it is articulated: as in the conjunction of the *femur* with the *tibia*.

The second species is, when a bone receives another at one end, and is received by the same bone at the other end; as in the *radius* and *ulna*.

The last sort is, when a bone receives another, and is received by a third; as in the oblique processes of the *vertebrae*.

When I first mentioned the articulations of bones, I said there were different opinions concerning the use of their technical names; e. g. It has been said, that *sympysis* should be the name for the immoveable articulations, and *synarthrosis* should be understood to be the conjunction of bones by some connecting *medium*.—Those who have taken *sympysis* in the sense I did, of its expressing the conjunction of bones with a connecting substance, have disagreed in their definition of it; some inserting, and others leaving out,

its

(c) *Articulatio mutua.*

(d) Baker Curs. osteolog. demonstr. 1.

(e) *Proximus.*

(f) *Longus.*

(g) *Compositus.*

its allowing motion.—Where they have agreed in their definition, they have not been of the same mind concerning the species of it. For several think the *Syphysis* and *syndesmosis* applicable to so many joints which are universally allowed to be classed under the *diarthrosis*, that it must create confusion to name them by any species of the *syphysis*.—Few keep to such a general definition of the *synchondrosis* as I have done; and, whether they determine it to allow no motion, or an obscure or a manifest one, bring themselves into difficulties, because there are examples of all these three kinds.—Some again, by too nicely distinguishing obscure and manifest motions of bones, have blended the *synarthrosis* and *diarthrosis*, and from thence have branched out the different compound species of articulations that may be formed of them, so far, that they could find no examples in the body to illustrate them by.—It would be tedious to enumerate more of the jarring opinions, and it would be far more so to give a detail of the arguments used by the disputants. It is sufficient for my purpose, that it is understood in what sense I take these technical terms; which I do in the following manner :

When I mention the *syphysis* or *synarthrosis*, or any species of them, I shall always understand them according to the explication already given of them. But though the preceding account of the *diarthrosis*, or articulation of moveable bones, has been almost universally received; yet, seeing it does not comprehend all the moveable articulations of the body, and one of its species does not answer to any notion we can have of the conjunction of two bones, I must beg leave to change the definitions and kinds of these joints.

I would call *diarthrosis* that conjunction of bones, whereby they are fitted for motion, being each covered with a smooth cartilage, connected by one or more common ligaments, and lubricated with liquor at the conjoined parts. In which definition, I have no regard to the quantity of motion which they real-

ly do perform; the motion being often confined or enlarged by some other cause not immediately depending on the frame of the two surfaces of the bones forming the particular joint which then is considered.

The first species of the *diarthrosis*, viz. the *enarthrosis*, or ball and socket, I would define more generally than above, That articulation where a round head of one bone is received into a cavity of another, and consequently, without some foreign impediment, is capable of motion to all sides. Examples of this kind are to be seen in the articulation of the thigh-bone and *os innominata*; arm-bone and *scapula*; *astragalus* and *os naviculare*; *magnum* of the wrist, with the *scaphoides* and *lunare*; first bone of the thumb with the second, &c.

The second sort, or the *arthrodia*, differing from the *enarthrosis*, in the preceding account, only in the cavity's being more superficial, which makes no essential difference, especially that, in the recent subject, cartilages or ligaments supply the deficiency of bone, ought, in my opinion, to be called with *Vesalius* (a), that articulation of two bones adapted for motion, where it is not at first sight obvious which of the two has the head or cavity, or where they are joined by plain surfaces, or nearly so; such is the conjunction of the *clavicle* with the *scapula*; *os cuneiformia* with the *os naviculare*; *metatarsal* bones with the *os cuneiformia*, &c. From the nature of this sort of joint, it is plain, that very great motion cannot be allowed, without the bones going farther out of their natural situation, than is convenient or safe.

Ginglimus, I would reckon that articulation by the form of which the motion of the joined bones must be chiefly confined to two directions, which hinges of doors are.

The first species of this is the *trochoides*, when one bone turns on another, as a wheel does on its axis: Thus the first *vertebra* of the neck moves on the tooth-

(a) *De corp. human. fabrica, lib. I. cap. 4.*

tooth-like process of the second. This is the most proper kind of *ginglimus*.

The second species should be esteemed that articulation where several prominent and hollow surfaces of two bones move on each other, within the same common ligament; as in the knee, elbow, &c.

The third sort of *ginglimus* is, when two bones are articulated to each other at different parts, with a distinct *apparatus* of the motory machines at each; such is the articulation of the *os occipitis* with the first *vertebra* of the neck; of any two contiguous *vertebrae*, by their oblique processes; of the ribs with the bodies and transverse processes of the *vertebrae*; of the *radius* with the *ulna*, *tibia* with the *fibula*, *astragalus* with the *calcaneum*, &c.

I would entirely throw out what is commonly called the third kind of *ginglimus*: For, in examining the conjunction of a bone with two others, as in the common example of a *vertebra* joined with the one above and below, the connection of the middle one with each of the other two ought to be considered separately; otherwise we might with the same propriety esteem the articulations that the long bones, the *femur*, *tibia*, *humerus*, &c. have at their different ends, as one articulation; which is absurd.

If the moveable bones are not connected and kept firm by some strong substance, they would be luxated at every motion of the joints: and if their hard rough unequal surfaces were to play on each other, their motion would not only be difficult, but the loss of substance from attrition would be great. Therefore *ligaments* are made to obviate the first, and *cartilages* to prevent the other inconvenience. But because ligaments and cartilages turn rigid, inflexible, and rough, unless they are kept moist, a sufficient quantity of proper liquors is supplied for their lubrication, and to preserve them in a flexible state. Seeing then these parts are so necessary to the articulations, I shall next consider their structure, situation, and uses,

uses, so far as they are subservient to the bones, and their motions.

LIGAMENTS (*a*) are white flexible bodies, thicker and firmer than membranes, and not so hard or firm as cartilages, without any remarkable cavity in their substance, difficultly stretched, and with little elasticity; serving to connect one part to another, or to prevent the parts to which they are fixed from being removed out of that situation which is useful and safe.

After maceration in water, the ligaments can easily be divided; and each ligamentous layer appears composed of fibres, the largest of which are disposed in a longitudinal direction.

The arteries of ligaments are very conspicuous after a tolerable injection, and the larger trunks of their veins are sometimes to be seen full of blood.

Such ligaments as form the sides of cavities, have numerous orifices of their arteries opening upon their internal surface, which keep it always moist: If we rub off that moisture, and then press the ligament, we can see the liquor oozing out from small pores; and we can force thin liquors injected by the arteries into the cavities formed by ligaments.

These exhalent arteries must have corresponding absorbent veins, otherwise the cavities would soon be too full of liquor.

Ligaments then must be subject to the diseases common to other parts, where there is a circulation of fluids, allowance always being made for the size of vessels, nature of the fluids, and firmness of the texture of each part.

Authors generally say, that ligaments are insensible: and consequently it may be inferred, that they have no nerves bestowed on them. But the violent racking pain felt on the least motion of a joint labouring under a *rheumatism*, the seat of which disease seems often to be in the ligaments, and the insufferable torture occasioned by incisions of ligaments, and by a col-

(a) Σύνδεσμοι, वृंपतः, सूपलाः, विनेला.

a collection of acrid matter in a joint, or by *tophi* in the gout, would persuade us, that they are abundantly supplied with nerves.

The ligaments which connect the moveable bones commonly rise from the conjunction of the *epiphysis* of the one bone, and are inserted into the same place of the other ; or where *epiphyses* are not, they come out from the *cervix*, and beyond the *superclia* of the articulated bones ; and after such a manner, in both cases, as to include the articulation in a purse or bag, with this difference, depending on their different motions, that where the motion is only to be in two directions, the ligaments are strongest on those sides towards which the bones are not moved ; and when a great variety of motions is designed to be allowed, the ligaments are weaker than in the former sort of articulations, and are nearly of the same strength all round.

Part of the capsular ligaments is composed of the *periosteum*, continued from one bone to another, as was observed p. 2. and their internal layer is continued on the parts of the bone or cartilage which the ligament includes (a).

Besides these common capsular ligaments of the joints, there are particular ones in several places, either for the firmer connection of the articulated bones, or for restraining and confining the motion to some one side ; such are the *cross* and *lateral* ligaments of the knee, the *round* one of the thigh, &c.

From this account of the ligaments, we may conclude, that, *cæteris paribus*, in whatever articulation the ligaments are few, long, and weak, the motion is more free and quick ; but luxations happen frequently : And, on the contrary, where the ligaments are numerous, short, and strong, the motion is more confined ; but such a joint is less exposed to luxations (b).—Whence we may judge how necessary it is to attend to the different ligaments, and the changes which

(a) Nesbit Osteogen.—Philos. transact. No. 470. sect 6.

(b) Fabric. ab. Aquapend. de articul. part. utilit. pars 3.

which have been made on them by a luxation, when it is to be reduced.

Ligaments also supply the place of bones in several cases to advantage: Thus the parts in the *pelvis* are more safely supported below by ligaments than they could have been by bone.—The ligaments placed in the great holes of the *os innominata*, and between the bones of the fore-arm and leg, afford convenient origin to muscles.—Immoveable bones are firmly connected by them; of which the conjunction of the *os sacrum* and *innominatum* is an example.—They afford a socket for moveable bones to play in, as we see part of the *astragalus* does on the ligament stretched from the heel-bone to the *scaphoid*.

Numerous inconveniences may arise from too long or short, strong or weak, lax or rigid ligaments.

CARTILAGES * are solid, smooth, white, elastic substances, between the hardness of bones and ligaments, and covered with a membrane, named *perichondrium*, which is of the same structure and use to them as the *periosteum* is to the bones.

Cartilages are composed of plates, which are formed of fibres, disposed much in the same way as those of bones are; as might be reasonably concluded from observing bones in a cartilaginous state before they ossify, and from seeing, on the other hand, so many cartilages become bony. This may be still further confirmed by the *exfoliation* which cartilages are subject to as well as bones.

The *perichondrium* of several cartilages, for example, those of the ribs and *larynx*, has arteries which can be equally well injected with those of the *periosteum*; but the vessels of that membrane in other parts, e. g. the articular cartilages, are smaller, and in none of them does injection enter deep into the substance of the cartilages; nay, madder, mixed with the food of animals, does not change the colour of cartilages as it does that of bones (*a*).

Discription OF THE Bones IN GENERAL.

* *Xovdpor.*

(*a*) Philos. Transact. No. 442. art. 8. No. 443. art. 2. No. 457. art. 4.—Mem. de l'acad. des sciences, 1739 et 1742.—Dchleef de ossium callo.

The granulated flesh which rises from the ends of metacarpal or metatarsal bones, when the cartilage exfoliates, after a finger or toe has been taken off at the first joint, is very sensible, from which the existence of nerves in cartilages may be inferred.

While cartilages are in a natural state, it is to be remarked, *first*, That they have no cavity in their middle for marrow. *Secondly*, That their outer surface is softest, which renders them more flexible. *Thirdly*, That they do not appear to change their texture near so much by acids as bones do. And, *lastly*, That as the specific gravity of cartilages is near a third less than that of bones; so the cohesion of their several plates is not so strong as in bones; whence cartilages laid bare in wounds or ulcers, are not only more liable to corrupt, but exfoliate much sooner than bones do.

Cartilages seem to be principally kept from ossifying, either by being subjected to alternate motions of flexion and extension, the effects of which are very different from any kind of simple pressure, or by being constantly moistened (*a*): Thus, the cartilages on the articulated ends of the great bones of the limbs, and the moveable ones placed between the moving bones in some articulations, which are obliged to suffer many and different flexions, and are plentifully moistened, scarce ever change into bone; while those of the ribs and larynx are often ossified.—The middle angular part of the cartilages of the ribs, which is constantly in an alternate state of flexion and extension, by being moved in respiration, is always the last of becoming bony.—In the *larynx*, the *epiglottis*, which is oftener bended and more moistened than the other four cartilages, seldom is ossified, while the others as seldom escape it in adults.

The cartilages subservient to bones, are sometimes found on the ends of bones which are joined to no other; but are never wanting on the ends, and in the cavities of such bones as are designed for motion (*b*).

Cartilages

(*a*) Havers Osteolog. nov.

(*b*) Cels. de re medic. lib. 8, cap. I.

Cartilages also are interposed between such other cartilages as cover the heads and cavities of articulated bones; nay, they are also placed between immovable bones.

The uses of cartilages, so far as they regard bones, are, to allow, by their smoothness, such bones as are designed for motion, to slide easily without detrition, while, by their flexibility, they accommodate themselves to the several figures necessary in different motions, and, by their elasticity, they recover their natural position and shape as soon as the pressure is removed.—This springy force may also assist the motion of the joint to be more expeditious, and may render shocks in running, jumping, &c. less.—To these cartilages we chiefly owe the security of the moveable articulations: For without them, the bony fibres would sprout out, and intimately coalesce with the adjoining bone; whence a true *ankylosis* must necessarily follow; which never fails to happen when the cartilages are eroded by acrid matter, or ossified from want of motion or defect of liquor, as we see often happens after wounds of the joints, *paindarthrocace*, *scrophula*, and *spina ventosa*, or from old age, and long immobility of joints (a).—Hence we may know what the annihilation is which is said to be made of the head of a bone, and of the cavity for lodging it, after an unreduced fracture (b). The moveable cartilages interposed in joints, serve to make the motions both freer and more safe than they would otherwise be.—Those placed on the ends of bones that are not articulated, as on the spine of the *os ilium*, base of the *scapula*, &c. serve to prevent the bony fibres from growing out too far.—Cartilages sometimes serve as ligaments, either to fasten together bones that are immovably joined, such are the cartilages between the *os sacrum* and *os ilium*, the *os pubis*, &c. or to connect

D 2

(a) Columb. de re anat. lib. 15.—Deslandes Hist. de l'acad. des sciences, 1716.—Phil. transact. No. 215.—Ibid. No. 461. § 16.

(b) Hildan. de ichor. et melicer. acri Celsi, cap. 5.—Ruysh. Thes. 8. No. 103.—Saltzman in act. Petropolit. tom. 3. p. 275.

connect bones that enjoy manifest motion, as those do which are placed between the bodies of the true *vertebra*, &c.—Cartilages very often do the office of bones to greater advantage than these last could, as in the cartilages of the ribs, those which supply brims to cavities, &c.

Too great thickness or thinness, length or shortness, hardness or suppleness of cartilages, may therefore cause great disorders in the body.

The liquor, which principally serves to moisten the ligaments and cartilages of the articulations, is supplied by glands, which are commonly situated in the joint, after such a manner as to be gently pressed, but not destroyed by its motion. By this means, when there is the greatest necessity for this liquor, that is, when the most frequent motions are performed, the greatest quantity of it must be separated. These glands are soft and pappy, but not friable: In some of the large joints they are of the conglomerate kind, or a great number of small glandules are wrapt up in one common membrane. Their excretory ducts are long, and hang loose, like so many fringes, within the articulation; which, by its motion and pressure, prevents obstructions in the body of the gland or its excretaries, and promotes the return of this liquor, when fit to be taken up by the absorbent vessels, which must be in the joints, as well as in the other cavities of the body; and, at the same time, the pressure on the excretory ducts hinders a superfluous unnecessary secretion, while the fimbriated disposition of these excretaries does not allow any of the secreted liquor to be pushed back again by these canals towards the glands (c).

Very often these fountains of slimy liquor appear only as a net-work of vessels—Frequently they are almost concealed by cellular membranes containing the fat—and sometimes small simple mucous *folliculi* may be seen (d).

The

(c) Cowper Anat. explicat. tab. 79. lit. E. E.

(d) Morgagn. Adversar. 2. animad. 23.

The different joints have these organs in different numbers and sizes; the conglomerate ones do not vary much, especially as to situation, in the similar joints of different bodies; but the others are more uncertain.

Upon pressing any of these glands with the finger, one can squeeze out of their excretaries a mucilaginous liquor, which somewhat resembles the white of an egg, or *serum* of the blood; but it is manifestly salt to the taste. It does not coagulate by acids, or by heat, as the *serum* does, but by the latter turns first thinner, and, when evaporated, leaves only a thin salt film.

The quantity of this *mucilage* constantly supplied, must be very considerable, since we see what a plentiful troublesome discharge of glary matter follows a wound or ulcer of any joint; of which liquor the mucilage is a considerable part.

The vessels which supply liquors for making the secretion of this mucilage, and the veins which bring back the blood remaining after the secretion, are to be seen without any preparation; and, after a tolerable injection of the arteries, the glands are covered with them.

In a sound state, we are not conscious of any sensibility in those glands; but, in some cases which I have seen, when they inflame and suppurate, the most racking pain is felt in them: a melancholy, though a sure proof that they have nerves.

These mucilaginous glands are commonly lodged in a cellular substance; which is also to be observed in other parts of the bag formed by the ligaments of the articulation; and contains a fatty matter, that must necessarily be attenuated, and forced through the including membranes into the cavity of the joint, by the pressure which it suffers from the moving bones.

If then the oil is conveyed from this cellular substance; and if the attenuated marrow passes from the *cancelli* of the bones by the large pores near their

ends, or in their cavities, and sweats through the cartilages there into the articulations; which it may, when assisted by the constant heat and action of the body, more easily do, than when it escapes through the compact substance of the bones in a skeleton: If, I say, this oil is sent to a joint, and is incorporated with the mucilage, and with the fine lymph that is constantly oozing out at the extremities of the small arteries distributed to the ligaments, one of the fittest *liniments* imaginable must be produced; for the *mucus* diluted by the lymph, contributes greatly to its lubricity, and the oil preserves it from hardening. How well such a mixture serves the purpose it is designed for, Boyle (e) tells us he experienced in working his air-pump; for the sucker could be moved with much less force after being moistened with water and oil, than when he used either one or other of these liquors: And I believe every one, at first view, will allow the diluted mucilage to be much preferable to simple water. The *synovia* (f), as this liquor composed of oil, mucilage, and lymph, is commonly now called, while in a sound state, effectually preserves all the parts concerned in the articulations soft and flexible, and makes them slide easily on each other, by which their mutual detrition and overheating is prevented, in the manner daily practised in coach and cart wheels, by besmearing them with grease and tar.

After the liquor of the articulations becomes too thin and unserviceable, by being constantly pounded and rubbed between the moving bones, it is reassumed into the mass of blood by the absorbent vessels.

When the *synovia* is not rubbed betwixt the bones, it inspissates. And sometimes, when the head of a bone has been long out of its cavity, this liquor is said to fill up the place of the bone, and hinder its reduction; or if a joint continues long unmoved, it is also said to cement the bones, and occasion a true

ankyloſis,

(e) Physico-mechanic. experim.

(f) *Muſa*, mucus, axungia,

anchyloſis (g).—If the *synovia* becomes too acrid, it erodes the cartilages and bones; as frequently happens to those who labour under the *lues venerea*, *scurvy*, *scrophula*, or *spina ventosa*.—If this liquor is separated in too small quantity, the joint becomes stiff; and when with difficulty it is moved, a crackling noise is heard, as people advanced in years frequently experience (h).—If the mucilage and lymph are deposited in too great quantity, and the absorbent vessels do not perform their office sufficiently, they may occasion a dropſy of the joints (i).—From this same cause also the ligaments are often ſo much relaxed, as to make the conjunction of the bones very weak: Thence arife the luxations from an internal cause, which are easily reduced, but diſſicultly cured (k).—Frequently, when ſuch a ſuperfluouſ quantity of this liquor is pent up, it becomes very acrid, and occations a great train of bad ſymptoms; ſuch as ſwelling and pain of the joints, long ſinuous ulcers, and *fiftulae*, rotten bones, immobility of the joints, *marcor* and *atrophia* of the whole body, hectic fevers, &c. (l).—From a depravity in the blood, or diseases in the organs that furnish the *synovia* of the joints, it may be greatly changed from its natural ſtate; it may be purulent after inflammation, mucous in the white ſwelling, gelatinous in the rheumatism, chalky from the gout, &c.; hence a great variety of disorders in the joints (m).

THE

(g) Pare Chirurgie, livre 15. chap. 18. et livre 16. chap. 5.

(h) Galen de uſu part. lib. 12. cap. 2.—Fabric. ab Aquapend. de articul. part. utilitat. pars 3.—Bartholin. Hist. medic. cent. 3. hist. II.

(i) Hildan. de iohore et meliceria acri Celsi.

(k) Hippocrat. de locis in homine, § 14. et de articul.

(l) Hildan. de iohore et meliceria acri Celsi.

(m) See Reimar, Differt. de fungo articulor.

THE
ANATOMY
OF THE
HUMAN BONES.

PART II.

Of the SKELETON.

THOUGH any dry substance may be called *skeleton*, yet, among anatomists, this word is universally understood to signify the bones of animals connected together, after the teguments, muscles, bowels, glands, nerves, and vessels are taken away (a).

A skeleton is said to be a *natural* one, when the bones are kept together by their own ligaments; and it is called *artificial*, when the bones are joined with wire, or any other substance which is not part of the creature to which they belonged. Small subjects, and such whose bones are not fully ossified, are commonly prepared the first way; because, were all their parts divided, the nicest artist could not rejoin them, by reason of their smallness, and of the separation of their unossified parts; whereas the bones of large adult animals are soonest and most conveniently cleaned when single, and are easily restored to, and kept in their natural situation.—Sometimes the skeleton

of

(a) Cadaveris crates.

of the same animal is prepared in both these ways; that is, the smaller bones are kept together by their natural ligaments, and the larger ones are connected by wires, or some such substances.

Before we proceed to the division and particular description of the skeleton, it is worth while to remark, that when the bones are put into their natural situation, scarce any of them is placed in a perpendicular bearing to another; though the fabric composed of them is so contrived, that, in an erect posture, a perpendicular line, from their common centre of gravity, falls in the middle of their common base (*b*). On this account, we can support ourselves as firmly, as if the axis of all the bones had been a straight line perpendicular to the horizon; and we have much greater quickness, ease, and strength, in several of the most necessary motions we perform. It is true, indeed, that where-ever the bones, on which any part of our body is sustained, decline from a straight line, the force required in the muscles, to counteract the gravity of that part, is greater than otherwise it needed to have been: But then this is effectually provided for in such places by the number and strength of the muscles. So long therefore as we remain in the same posture, a considerable number of muscles must be in a constant state of contraction; which, we know, both from reason and experience, must soon create an uneasy sensation. This we call, being weary of one posture: An inconvenience that we should not have had in standing erect, if the bearing of all the bones to each other had been perpendicular; but is more than compensated by the advantages above mentioned.

The human skeleton is generally divided into the HEAD, the TRUNK, the SUPERIOR, and the INFERIOR EXTREMITIES.

OF

(*b*) Cowper's Anat. of human bodies, explic. of tab. 87, 88.

OF THE HEAD.

BY the *HEAD*, is meant all that spheroidal part which is placed above the first bone of the neck. It therefore comprehends the *cranium* and bones of the *face*.

The *cranium* (*c*), helmet, or brain-case, consists of several pieces, which form a vaulted cavity, for lodging and defending the brain and *cerebellum*, with their membranes, vessels, and nerves.

The cavity of the *cranium* is proportioned to its contents. Hence such a variety of its size is observed in different subjects; and hence it is neither so broad nor so deep at its fore-part, in which the anterior lobes of the brain are lodged, as it is behind, where the large posterior lobes of the brain, and the whole *cerebellum*, are contained.

The roundish figure of the skull, which makes it more capacious, and better able to defend its contents from external injuries, is chiefly owing to the equal pressure of these contained parts as they grow and increase before it is entirely ossified.—It is to be observed, however, that the sides of the *cranium* are depressed below a spherical surface by the strong temporal muscles, whose action hinders here the uniform protrusion of the bones, which is more equally performed in other parts, where no such large muscles are. In children, whose muscles have not acted much, and consequently have not had great effects on the bones, this depression is not so remarkable; and therefore their heads are much rounder than in adults. These natural causes, differently disposed in different people, produce a great variety in the shapes of skulls, which is still increased by the different management of the heads of children when very young: So that one may know a *Turk's* skull by its globular figure, a *German's* by its breadth and flatness of the *occiput*,

Dutch

(c) Κογχος, κυρος, κωδεια, σκαφιον, calva, calvaria, cerebri galea, theca et olla capitis, testa capititis, scutella capititis.

Dutch and English by their oblong shapes, &c. (d). Two advantages are reaped from this flatness of the sides of the *cranium*, viz. the enlargement of our sphere of vision, and more advantageous situation of our ears, for receiving a greater quantity of sound, and for being less exposed to injuries.

The external surface of the upper part of the *cranium* is very smooth, and equal, being only covered with the *periosteum*, (common to all the bones; but in the skull, distinguished by the name of *pericranium*), the thin *frontal* and *occipital* muscles, their tendinous *aponeurosis*, and with the common teguments of the body; while the external surface of its lower part has numerous risings, depressions, and holes, which afford convenient origin and insertion to the muscles that are connected to it, and allow safe passage for the vessels and nerves that run through and near it.

The internal surface of the upper part of the skull is commonly smooth, except where the vessels of the *dura mater* have made furrows in it, while the bones were soft.—Surgeons should be cautious when they trepan here, lest, in sawing or raising the bone where such furrows are, they wound these vessels.—In the upper part of the internal surface of several skulls, there are likewise pits of different magnitudes and figures, which seem to be formed by some parts of the brain being more luxuriant and prominent than others. Where these pits are, the skull is so much thinner than any where else, that it is often rendered diaphanous, the two tables being closely compacted without a *diploe*; the want of which is supplied by vessels going from the *dura mater* into a great many small holes observable in the pits. These vessels are larger, and much more conspicuous than any others that are sent from the *dura mater* to the skull; as evidently appears from the drops of blood they pour out, when the skull is raised from the *dura mater* in a recent subject; and therefore they may furnish

(d) Vesal. lib. 1. c. 5.

furnish a sufficient quantity of liquors necessary to prevent the brittleness of this thin part.—The knowledge of these pits should teach surgeons to saw cautiously and slowly through the external table of the skull, when they are performing the operation of the trepan; since, in a patient whose *cranium* has these pits, the *dura mater* and brain may be injured, before the instrument has pierced near the ordinary thickness of a table of the skull.—The internal base of the skull is extremely unequal, for lodging the several parts and appendices of the brain and *cerebellum*, and allowing passage and defence to the vessels and nerves that go into, or come out from these parts.

The bones of the *cranium* are composed of two tables, and intermediate *cancelli*, commonly called their *diploe* (*e*). The external table is thickest; the inner, from its thinness and consequent brittleness, has got the name of *vitrea*. Whence we may see the reason of those mischievous consequences which so often attend a collection of matter in the *diploe*, either from an external or internal cause, before any sign of such a collection appears in the teguments that cover the part of the skull where it is lodged (*f*).

The *diploe* has much the same texture and uses in the skull, as the *cancelli* have in other bones.

The *diploe* of several old subjects is so obliterated, that scarce any vestige of it can be seen; neither is it observable in some of the hard craggy bones at the base of the skull. Hence an useful caution to surgeons who trust to the bleeding, want of resistance, and change of sound, as certain marks in the operation of the trepan, for knowing when their instrument has sawed through the first table, and reached the *diploe* (*g*). In other people, the *diploe* becomes of a monstrous thickness, while the tables of the skull are thinner than paper.

E

The

(*e*) *Meditullium, commissura.*

(*f*) *Bonet. Sepulchret. anat. lib. 1. § 1. obs. 96.—103.*

(*g*) *Bartholin. Anat. reform. lib. 4. cap. 4.*

*The cranium consists of eight bones, six of which are said to be proper, and the other two are reckoned common to it and to the face.—The six proper are, the *os frontis*, two *os parietalia*, two *os temporum*, and the *os occipitis*.—The common are the *os ethmoides* and *os sphenoides*.*

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The *os frontis* forms the whole fore part of the vault; the two *os parietalia* form the upper and middle part of it; the *os temporum*, compose the lower part of the sides; the *os occipitis* makes the whole hinder part, and some of the base; the *os ethmoides* is placed in the fore part of the base, and the *os sphenoides* is in the middle of it.

These bones are joined to each other by five *sutures*; the names of which are, the *coronal*, *lambdoid*, *sagittal*, and two *squamous*.

The *coronal* (*b*) *suture* is extended over the head, from within an inch or so of the external *canthus* of one eye, to the like distance from the other; which being near the place where the ancients wore their *vitta*, *corona*, or garlands, this *suture* has hence got its name.—Though the indentations of this *suture* are conspicuous in its upper part, yet an inch or more of its end on each side has none of them; for it is *squamous* and smooth there.

The *lambdoidal* (*i*) *suture* begins some way below, and farther back than the *vertex* or crown of the head, whence its two legs are stretched obliquely downwards, and to each side, in form of the Greek letter Δ , and are now generally said to extend themselves to the *base* of the skull; but formerly anatomists (*k*) reckoned the proper *lambdoid* *suture* to terminate at the *squamous* *sutures*, and what is extended at an angle down from that on each side, where the indentations are less conspicuous than in the upper part of the *suture*, they called *additamentum suture lambdoidis* (*l*).

This

(*b*) Στριψανία, *arcualis*, *puppis*.

(*i*) Laudæ, proræ, *hypofloides*.

(*k*) Vefal. Anat. lib. i. cap. 6.

(*l*) *Lambdoides harmonialis*, *lambdoides inferior*, *occipitis corona*.

This *suture* is sometimes very irregular, being made up of a great many small sutures, which surround so many little bones that are generally larger and more conspicuous on the external surface of the skull, than internally. These bones are generally called *triquetra*, or *Wormiana*; but some other name ought to be given them, for they are not always of a triangular figure; and older anatomists (*m*) than *Olaus Wormius* (*n*) have described them.—The specific virtue which these bones were once thought to have in the cure of the epilepsy (*o*) is not now ascribed to them; and anatomists generally agree, that their formation is owing to a greater number of points than ordinary of ossification in the skull, or to the ordinary bones of the *cranium* not extending their ossification far enough or soon enough; in which case, the unossified interstice between such bones begins a separate ossification in one or more points: from which the ossification is extended to form as many distinct bones as there were points that are indented into the large ordinary bones, and into each other.—Probably those children who have a large opening in this place at their birth, will have the largest *os triquetra*.—To confirm this account of the formation of these little bones, we may remark, that such bones are sometimes seen in other sutures, as well as in the *lambdoid* (*p*), and they are sometimes in one table of the skull, and not in the other (*q*).)

The *sagittal* suture (*r*) is placed longitudinally in the middle of the upper part of the skull, and com-

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monly

(*m*) Eustach. *Ossium examen*.—Bauhin. *Theat. anat.* lib. 3. cap. 5.—Paaw in *Hippocrat. de vulner.* cap. p. 56.

(*n*) *Musæum*, lib. 3. cap. 26.

(*o*) Bauhin. et Paaw. *ibid.*—Bartholin. *Anat. reform.* lib. 4. cap. 5.—Hildan. *Epist.* 63.

(*p*) See Examples in Vesal. lib. 1. cap. 6. fig. 4.—Paaw in *Hippocrat. de cap. vuln.*—Bartholin. *Hist. anat. cent.* 1. *hist.* 51.—Ruysch. *Mus. anat.*—Sue Trad. d'osteolog. p. 47.

(*q*) Huanudi *Mem. de l'acad. des. sciences*, 1730.

(*r*) Παρθονίς, ὀλεκτική, ἵπτευγμα, *Instar virgē, nervalis, instar teli, instar verū, secundum capitis longitudinem prorepens, conjungens, columnalis, recta, acualis.*

monly terminates at the middle of the *coronal*, and of the *lambdoid* sutures; between which it is said to be placed, as an arrow is between the string and bow.—However, this suture is frequently continued through the middle of the *os frontis*, down to the root of the nose; which, some (*s*) say, oftener happens in women than men; but others (*t*) alledge, that it is to be met with more frequently in male skulls than in female: Among the skulls which I have seen thus divided, the female are the most numerous.—Several (*u*) have delineated and described the *sagittal* suture, sometimes dividing the *occipital* bone as far down as the great hole through which the *medulla spinalis* passes. This I never saw.

In some old sculls that are in my possession, there is scarce a vestige of any of the three *sutures* which I have now described. In other heads, one or two of the sutures only disappear; but I never could discover any reason for thinking them disposed in such different manners in sculls of different shapes, as some ancients alledge they are (*d*).

The *squamous agglutinations*, or *false sutures* (*e*), are one on each side, a little above the ear, of a semicircular figure, formed by the overlopping (like one scale upon another) of the upper part of the *temporal* bones on the lower part of the *parietal*, where, in both bones, there are a great many small risings and furrows, which are indented into each other; though these inequalities do not appear till the bones are separated. In some sculls indeed the indentations here are as conspicuous externally as in other sutures (*f*); and what is commonly called the posterior part of this

squamous

(*s*) Riolan. Comment. de ossib. cap. 8.

(*t*) Vesal. lib. 1. cap. 6. et in epitome.

(*u*) Vesal. lib. 1. cap. 5. fig 3, 4. et in text. cap. 6.—Paaw in Cels. de re medic. cap. 1.—Laurent. Hist. anat. lib. 2. cap. 16.

(*d*) Hippocrat. de vulner. capititis, sect. 1.—Galen de ossib. et de mu part. lib. 9. cap. 17.

(*e*) Αιπεδούδη, προτολληματα, χροταρια, temporales, corticales, mendosae, harmoniales, commissuræ in unguem.

(*f*) Columb. de re anat. lib. 1. cap. 4.—Dionis Anat. 3. de monst. des os.

squamous suture, always has the evident serrated form; and therefore is reckoned by some (g), a distinct suture, under the name of *additamentum posterius suturae squamosa*.—I have seen two squamous sutures on the same temple, with a semicircular piece of bone between them (h).

We ought here to remark, that the true squamous sort of suture is not confined to the conjunction of the temporal and parietal bones, but is made use of to join all the edges of the bones on which each temporal muscle is placed (i): For the two parts of the sphenoidal suture which are continued from the anterior end of the common squamous suture just now described, of which one runs perpendicularly downwards, and the other horizontally forwards, and also the lower part of the coronal suture already taken notice of, may all be justly said to pertain to the squamous suture.—The manner how I imagine this sort of suture is formed at these places, is, That by the action of the strong temporal muscles on one side, and by the pressure of the brain on the other, the bones are made so thin, that they have not large enough surfaces opposed to each other to stop the extension of their fibres in length, and thus to cause the common serrated appearance of sutures explained in p. 30. but the narrow edge of the one bone slides over the other. The *squamous* form is also more convenient here; because such thin edges of bones, when accurately applied one to another, have scarce any rough surface, to obstruct or hurt the muscle in its contraction; which is still further provided for, by the manner of laying these edges on each other; for in viewing their outside, we see the temporal bones covering the sphenoidal and parietal, and this last supporting the sphenoidal, while both mount on the frontal: from which disposition it is evident, that while the temporal muscle is contracting, which is the only time it presses

E 3

strongly

(g) Albin. de ossib. sect. 54.

(h) Sue Trad. d'osteolog. p. 48.

(i) Vesal. Anat. lib. I. cap. 6.—Winslow Mem. de l'acad. des sciences, 1720.

strongly in its motion on the bones, its fibres slide easily over the external edges. Another advantage still in this is, that all this bony part is made stronger by the bones thus supporting each other.

The bones of the scull are joined to those of the face, by *synchondrosis* and *futures*.—The *synchondrosis* is in the partition of the nose.—The *futures* said to be common to the *cranium* and face are five, *viz.* the *ethmoidal*, *sphenoidal*, *transverse*, and two *zygomatic*.—Parts however of these *futures* are at the junction of only the bones of the scull.

The *ethmoidal* and *sphenoidal* *futures* surround the bones of these names; and in some places help to make up other *futures*, particularly the *squamous*-and *transverse*; and in other parts there is but one *future* common to these two bones.

The *transverse* *future* is extended quite cross the face, from the external *canthus* of one orbit to the same place of the other, by sinking from the *canthus* down the outside of the orbit to its bottom; then mounting upon its inside, it is continued by the root of the nose down the internal part of the other orbit, and rises up again on its outside to the other *canthus*. It may be here remarked, that there are some interruptions of this *future* in the course I have described; for the bones are not contiguous every where, but are separated, to leave holes and apertures, to be mentioned hereafter.

The *zygomatic* *futures* are one on each side, being short, and slanting from above obliquely downwards, and backwards, to join a process of the cheek-bone to one of the *temporal* bones, which advances towards the face; so that the two processes thus united, form a sort of bridge, or *jugum*, under which the *temporal* muscle passes; on which account the processes, and *future* joining them, have been called *zygomatic*.

It must be observed, that the indentations of the *futures* do not appear on the inside of the *cranium*, by much so strong as on the outside: but the bones seem almost joined in a straight line; nay, in some

sculls,

sculls, the internal surface is found entire, while the fures are manifest without; which may possibly be owing to the less extent of the concave than of the convex surface of the *cranium*, whereby the fibres of the internal side would be stretched farther out at the edges of the bones, than the exterior ones, if they were not resisted. The resistances are the fibres of the opposite bone, the parts within the scull, and the *diploe*; of which the last being the weakest, the most advanced fibres or *serræ* run into it, and leave the contiguous edges equal, and more ready to unite: whereas the *serræ* of the external table have space enough for their admission between the fibres of the opposite bone, and therefore remain of the indented form, and are less liable to the concretion, whereby the fures are obliterated (a).—By this mechanism, there is no risk of the sharp points of the bones growing inwards, since the external *serræ* of each of the conjoined bones rest upon the internal smooth edged table of the other; and external forces applied to these parts are strongly resisted, because the fures cannot yield, unless the serrated edges of the one bone, and the plain internal plate of the other, are broken (b).

The advantages of the fures of the *cranium* are these: 1. That this *capsula* is more easily formed and extended into a spherical figure, than if it had been one continued bone. 2. That the bones which are at some distance from each other at birth, might then yield, and allow to the head a change of shape, accommodated to the passage it is engaged in. Whence, in hard labour of child-bed, the bones of the *cranium*, instead of being only brought into contact, are sometimes made to mount one upon the other. 3. It is alledged, that, through the fures, there is a transpiration of steams from the brain, which was the old doctrine; or some communication of the vessels without, and of those within the scull, larger here than in any other part of the *cranium*, according to some moderns.

(a) Hunauld Memoires de l'acad. des sciences, 1730.

(b) Winslow Memoires de l'acad. des sciences, 1720.

moderns; and therefore *cucupha*, *fomentations*, *cata-plasms*, *cephalic plasters*, *blisters*, are applied, and *tissues* are eroded, or cut in the head, at those places where the *sutures* are longest in forming, and where the connection of the bones is afterwards loosest, for the cure of a *phrenitis*, *mania*, *inveterate headache*, *epilepsy*, *apoplexy*, and other diseases of the head. The favourers of the doctrine of transpiration, or communication of vessels at the *sutures*, endeavour to support it by observations of persons subject to headaches which caused death, from the *sutures* being too closely united (*a*). 4. That the *dura mater* may be more firmly suspended by its processes, which insinuate themselves into this conjunction of the bones; for doing this equally, and where the greatest necessity of adhesion is, the *sutures* are disposed at nearly equal distances, and the large *reservoirs* of blood, the *sinuses*, are under or near them. 5. That fractures might be prevented from reaching so far as they would in a continued bony substance. 6. That the connection at the *sutures* being capable of yielding, the bones might be allowed to separate; which has given great relief to patients from the violent symptoms which they had before this separation happened (*d*). And it seems reasonable to believe, that the opening of the *sutures* was of great benefit to several others who were rather judged to have been hurt by it (*b*): for we must think, that the consequences of such a force acting upon the brain, as was capable of thrusting the bones asunder, must have been fatal, unless it had been thus yielded to.

- Having gone through the general structure of the *cranium*, I now proceed to examine each bone of which

(*a*) Columb. de re anat. lib. 1. cap. 5.—Verdier. nouvelle ostéologie, chap. 14.—Dionis Anat. 3. démonstr. des os.

(*d*) Ephemerid. Germanic. dec. 1. ann. 4. et 5. observ. 33.

(*b*) Ephemerid. Germ. dec. 2. ann. 9. obs. 230. Ibid. cent. 10. obs. 31.—Vander Linden Medicin. phys. cap. 8. art. 4. § 16.—Hildan. Observ. cent. 1. obs. 1. cent. 2. obs. 7.—Bauhin. Theat. anat. lib. 3. cap. 6.—Pechlin. Observ. lib. 2. observ. 39.

of which that brain-case consists, in the order in which I first named them.

The *OS FRONTIS* (c) has its name from its being the only bone of that part of the face we call the *fore-head*, though it reaches a good deal farther. It has some resemblance in shape to the shell of the *concha bevalvis*, commonly called the *cockle*; for the greatest part of it is convex externally, and concave internally, with a serrated circular edge; while the smaller part has processes and depressions, which make it of an irregular figure.

The external surface of the *os frontis* is smooth at its upper convex part; but several processes and cavities are observable below: for, at each angle of each orbit, the bone juts out, to form four processes, two internal, and as many external; which, from this situation, may well enough be named *angular*. Between the internal and external angular processes on each side, an arched ridge is extended, on which the eye-brows are placed.—Very little above the internal end of each of these *superciliary* ridges, a protuberance may be remarked, in most skulls, where there are large cavities, called *sinuses*, within the bone; of which hereafter.—Betwixt the internal angular processes, a small process rises, which forms some share of the nose, and thence is named *nasal*.—Some observe a protuberant part on the edge of the bone behind each external angular process, which they call *temporal* processes; but these are inconsiderable.—From the under part of the superciliary ridges, the frontal bone runs a great way backwards: which parts may justly enough be called *orbital* processes. These, contrary to the rest of this bone, are concave externally, for receiving the globes of the eyes, with their muscles, fat, &c.

In each of the *orbital* processes, behind the middle of the superciliary ridges, a considerable sinuosity is observed, where the *glandula innominata Galeni* or *lacrymalis*

(c) *Metωπος*, *Επίγυατα*, *coronale*, *inverecundum*, *puppis*, *sensus communis*, *sincipitis*.

chrymalis is lodged.—Behind each internal angular process, a small pit may be remarked, where the cartilaginous pully of the *musculus obliquus major* of the eye is fixed.—Betwixt the two orbital processes, there is a large discontinuation of the bone, into which the cibriform part of the *os ethmoides* is incased.—The frontal bone frequently has little caverns formed in it here where it is joined to the ethmoid bone.—Behind each external angular process, the surface of the frontal bone is considerably depressed where part of the *temporal* muscle is placed.

The *foramina*, or holes, observable on the external surface of the frontal bone, are three in each side.—One in each superciliary ridge, a little removed from its middle towards the nose; through which a twig of the *ophthalmic* branch of the fifth pair of nerves passes out of the orbit, with a small artery from the internal carotid, to be distributed to the teguments and muscles of the forehead.—These vessels in some skulls make furrows in the *os frontis*, especially in the bones of children, as has also been observed of another considerable vessel of this bone near its middle (*a*); and therefore we ought to beware of transverse incisions on either side of the *os frontis*, which might either open these vessels or hurt the nerves, while they are yet in part within the bone; for, when vessels are thus wounded, it is difficult to stop the haemorrhagy, because the adhesion of a part of the artery to the bone hinders its contraction, and consequently styptics can have little effect; the sides of the furrow keep off compressing substances from the artery; and we would wish to shun cauteries or escharotics, because they make the bone carious; and nerves, when thus hurt, sometimes produce violent symptoms.—But, to return to the *superciliary foramina*, we must remark, that often, instead of a hole, a notch only is to be seen: Nay, in some skulls, scarce a vestige even of this is left; in others, both hole and notch are observable, when the nerve and artery run separately.

Frequently

(*a*) Ruysh. Mus. anat. theca D. deposit. 4, No. 3.

Frequently a hole is found on one side, and a notch on the other; at other times we see two holes; or there is a common hole without, and two distinct entries internally. The reason of this variety of a hole, notch, depression, or smoothness in the superciliary ridge, is the different length and tension of the nerves and vessels; the shorter they are, the more they are sunk into the bone as it grows.—Near the middle of the inside of each orbit, hard by, or in the *transverse suture*, there is a small hole for the passage of the nasal twig of the first branch of the fifth pair of nerves, and of a branch of the ophthalmic artery. This hole is sometimes entirely formed in the *os frontis*; in other skulls, the sides of it are composed of this last bone, and of the *os planum*. It is commonly known by the name of *orbitarium internum*, though *anterius* should be added, because of the next, which is commonly omitted.—This, which may be called *orbitarium internum posterius*, is such another as the former; only smaller, and about an inch deeper in the orbit: through it a small branch of the ocular artery passes to the nose.—Besides these six, there are a great number of small holes observable on the outer surface of this bone, particularly in the two protuberances above the eyebrows. Most of these penetrate no further than the *sinuses*, or than the *diploe*, if the *sinuses* are wanting; though sometimes I have seen this bone so perforated by a vast number of these small holes, that, placed between the eye and a clear light, it appeared like a sieve.—In the orbit of the generality of *skeletons*, we may observe one, two, or more holes, which allow a passage to a hog's bristle through the scull. The place, size, and number of these, are however uncertain: They generally serve for the transmission of small arteries or nerves.

The internal surface of the *os frontis* is concave, except at the orbital processes, which are convex, to support the anterior lobes of the brain. This surface is not so smooth as the external; for the larger branches

of

of the arteries of the *dura mater* make some furrows in its sides and back parts. The sinuosities from the luxuriant risings of the brain, mentioned when describing the general structure of the *cranium*, are often very observable on its upper part; and its lower and fore parts are marked with the contortions of the anterior lobes of the brain.—Through the middle of this internal surface, where always in children, and sometimes in old people, the bone is divided, either a ridge stands out, to which the upper edge of the *falx* is fastened, or a furrow runs, in which the upper side of the superior longitudinal *sinus* is lodged; on both these accounts chirurgical authors justly discharge the application of the trepan here.—The reason of this difference in sculls, is alledged by some authors to be this, That in thin sculls the ridge strengthens the bones, and in thick ones there is no occasion for it. To this way of accounting for this phenomenon, it may justly be objected, that generally very thick sculls have a large spine here, and frequently thin ones have only a furrow. Perhaps this variety may be owing to the different times of compleat ossification of those parts in different subjects; for if the two sides of this bone meet before they arrive at their utmost extent of growth, they unite very firmly, and all their fibres endeavour to stretch themselves out where the least resistance is, that is, between the hemispheres of the brain. To support this reasoning, we may remark, that those adults, whose frontal bone is divided by the sagittal suture, never have a ridge in this place.

Immediately at the root of this ridge or furrow, there is a small hole, which sometimes pierces through the first table, and, in other sculls, opens into the superior *sinus* of the *ethmoid* bone within the nose. In it a little process of the *falx* is lodged, and a small artery, and sometimes a vein, runs (*a*); and the superior longitudinal *sinus* begins here.—This hole, however, is often not entirely proper to the *os frontis*; for, in

(*a*) Morgagn. Adversar. 6. animad. 31.

in several skulls, the lower part of it is formed in the upper part of the base of the *crista galli*, which is a process of the ethmoid bone (z).

The *os frontis* is composed of two tables, and an intermediate *diploe*, as the other bones of the *cranium* are, and in a middle degree of thickness between the *os occipitis* and the *parietal* bones; is pretty equally dense all through, except at the orbital processes, where, by the action of the eye on one side, and pressure of the lobes of the brain on the other, it is made extremely thin and diaphanous, and the *medullum* is entirely obliterated. Since in this place there is so weak a defence for the brain, the reason appears, why fencers esteem a push in the eye mortal (a).

The *diploe* is also exhausted in that part above the eye-brows, where the two tables of the bone separate, by the external being protruded outwards, to form two large cavities called *sinus frontales*.—These are divided by a middle perpendicular bony partition.—Their capacities in the same subject are seldom equal; in some the right, in others the left is largest.—And in different bones their size is as inconstant; nay, I have examined some, where they were entirely wanting; which oftener happens in such as have a flat forehead, and whose sagittal suture is continued down to the nose, than in others (b).—In some skulls, besides the large perpendicular *septum*, there are several bony pillars, or short partitions, found in each *sinus*; in others these are wanting.—For the most part, the *septum* is entire; at other times it is discontinued, and the two *sinuses* communicate.—When the *sinuses* are seen in such skulls as have the frontal bone divided by the sagittal suture, the partition dividing these cavities is evidently composed of two plates, which easily separate.—Each *sinus* com-

F

monly

(z) Ingraff. Comment. in Galen. de ossib. cap. 1. comment. 8.

(a) Ruyisch. Observ. anat. chir. observ. 54.—Diemerbroek Anat. lib. 3. cap. 10.—Bonet. Sepulch. anat. lib. 4. § 3. observ. 17.

(b) Fallop. Exposit. de ossibus, cap. 13.

monly opens by a roundish small hole, at the inner and lower part of the internal angular processes, into a *sinus* formed in the nose, at the upper and back part of the *os unguis*; near to which there are also some other small *sinuses* of this bone (*c*), the greater part of which open separately, nearer the *septum narium*, and often they terminate in the same common canal with the large ones.

In a natural and sound state, these cavities are of considerable advantage: for the organ of smelling being thus enlarged, the *effuvia* of odorous bodies more difficultly escape it; and their impressions being more numerous, are therefore stronger, and affect the organ more. That odorous particles may be applied to the membrane of the *sinuses*, is evident from the pain felt in this part of the forehead, when the *effuvia* of volatile spirits, or of strong aromatics, are drawn up into the nose by a quick inspiration.—These and the other cavities which open into the nose, increase the sound of our voice, and render it more melodious, by serving as so many vaults to resound the notes.—Hence people labouring under a *coryza*, or stoppage of the nose, from any other cause, when they are by the vulgar, though falsely, said to speak through their nose, have such a disagreeable harsh voice.—The liquor separated in the membrane of these *sinuses*, drills down upon the membrane of the nose to keep it moist.

From the description of these *sinuses*, it is evident, how useless, nay, how pernicious it must be, to apply a trepan on this part of the scull; for this instrument, instead of piercing into the cavity of the *cranium*, would reach no further than the *sinuses*; or, if the inner table was perforated, any extravasated blood that happened to be within the scull, would not be discharged outwardly, but would fall into the *sinuses*, there to stagnate, corrupt, and stimulate the sensible membranes; from which also there would be such a constant flow of glary mucus, as would retard, if not

(c) Cowper in Drake's Anthropolog. book 3. chap. 10.

not hinder a cure, and would make the sore degenerate into an incurable *fistula*. Besides, as it would be almost impossible in this case to prevent the air, passing through the nose, from having constant access to the *dura mater*, or brain; such a corruption would be brought on these parts as would be attended with great danger. Further, in respiration, the air rushing violently into these cavities of the *os frontis*, and passing through the external orifice, whenever it was not well covered and defended, would not only prevent the closing up of the external orifice, but might otherwise bring on bad consequences (*d*).—The membrane lining these *sinuses* is so sensible, that inflammations of it must create violent torture (*e*); and worms, or other insects crawling there, must give great uneasiness (*f*).

The upper circular part of the *os frontis*, is joined to the *os parietalia*, from one temple to the other, by the coronal suture. From the termination of the coronal suture, to the external angular processes, this bone is connected to the *sphenoid* by the *sphenoidal* suture. At the external *cantii* of the eyes, its angular processes are joined by the transverse suture to the *os malarum*, to which it adheres one third down the outside of the orbits; whence to the bottom of these cavities, and a little up on their internal sides, these orbital processes are connected to the *sphenoidal* bone by that same suture.—In some few skulls, however, a discontinuation of these two bones appears at the upper part of the long slit, near the bottom of the orbit.—On the inside of each orbit, the orbital process is indented between the *cribriform* part of the *ethmoid* bone, and the *os planum* and *unguis*.—The transverse suture afterwards joins the frontal bone to the superior nasal processes of the *os maxillaria superriora*,

F 2

(*d*) Paaw de ossibus, pars 1. cap. 7.—Palfyne Anat. chir. traité 4. chap. 15.—Nouvelle osteologie, partie 2. chap. 3.

(*e*) Fernel. Patholog. lib. 5. cap. 7.—Saltzman. Decur. obs. 10.

(*f*) Fernel. Patholog. lib. 5. cap. 7.—Bartholin. Epistol. medic. cent. 2. epist. 74.—Hist. de l'acad. des sciences, 1708 & 1733.

riora, and to the nasal bones. And, *lastly*, its nasal process is connected to the nasal *lamella* of the *ethmoid* bone.

The *frontal* bone serves to defend and support the anterior lobes of the brain. It forms a considerable part of the cavities that contain the globes of the eyes, helps to make up the *septum narium*, organ of smelling, &c. From the description of the several parts, the other uses of this bone are evident.

In a ripe child, the frontal bone is divided through the middle; the superciliary holes are not formed; often a small round piece of each orbital process, behind the superciliary ridge, is not ossified, and there is no *sinus* to be seen within its substance.

Each of the two *OSSA PARIETALIA* (g), or bones serving as walls to the *encephalon*, is an irregular square; its upper and fore sides being longer than the one behind or below. The inferior side is a concave arch; the middle part receiving the upper round part of the temporal bone.—The angle formed by this upper side, and the fore one, is so extended, as to have the appearance of a process.

The external surface of each *os parietale* is convex. Upon it, somewhat below the middle height of the bone, there is a transverse arched ridge, of a whiter colour generally than any other part of the bone; from which, in bones that have strong prints of muscles, we see a great many converging furrows, like so many *radii* drawn from a circumference towards a centre. From this ridge of each bone the temporal muscle rises; and, by the pressure of its fibres, occasions the furrows just now mentioned.—Below these, we observe near the semicircular edges, a great many risings and depressions, which are joined to like inequalities on the inside of the temporal bone, to form the squamous future. The temporal bone may therefore serve here as a buttress, to prevent

(g) Κορυφή, paria, syncipitis, verticis, arcuata, nervalia, cogitationis, rationis, bregmatis, madefactionis.

vent the lower side of the parietal from starting outwards when its upper part is pressed or struck (*b*).

Near the upper sides of these bones, towards the hind part, is a small hole in each, through which a vein passes from the teguments of the head to the longitudinal *sinus*. Sometimes I have seen a branch of the temporal artery pass through this hole, to be distributed to the upper part of the *falx*, and to the *dura mater* at its sides, where it had frequent anastomoses with the branches of the arteries derived from the external carotids, which commonly have the name of the arteries of the *dura mater*, and with the branches of the internal carotids which serve the *falx*. In several sculls, one of the *osseous parietalia* has not this hole: in others, there are two in one bone; and in some not one in either. Most frequently this hole is through both tables; at other times the external table is only perforated.—The knowledge of the course of these vessels may be of use to surgeons, when they make any incision near this part of the head, lest, if the vessels are rashly cut near the hole, they shrink within the substance of the bone, and so cause an obstinate haemorrhagy, which neither ligatures nor medicines can stop.

On the inner concave surface of the parietal bones, we see a great many deep furrows, disposed somewhat like the branches of trees: The furrows are largest and deepest at the lower edge of each *os. parietale*, especially near its anterior angle, where sometimes a full canal is formed. They afterwards divide into small furrows, in their progress upwards.—In some sculls a large furrow begins at the hole near the upper edge, and divides into branches, which join with those which come upwards, shewing the communications of the upper and lower vessels of the *dura mater*.—In these furrows we frequently see passages into the *diploë*; and sometimes I have observed canals going off, which allowed a small probe to pass some

inches into the bony substance. Some (i) tell us, that they have observed these canals piercing the bone towards the *occiput*.—On the inside of the upper edge of the *osseum parietalia*, there is a large sinuosity, frequently larger in the bone of one side than of the other, where the upper part of the *falx* is fastened, and the superior longitudinal *sinus* is lodged.—Generally part of the latter *sinuses* makes a depression near the angle, formed by the lower and posterior sides of these bones; and the pits made by the prominent parts of the brain are to be seen in no part of the scull more frequent, or more considerable, than in the internal surface of the parietal bones.

The *osseum parietalia* are amongst the thinnest bones of the *cranium*; but enjoy the general structure of two tables and *diploe* the completest, and are the most equal and smooth.

These bones are joined at their fore-side to the *os frontis* by the coronal suture; at their long inferior angles, to the *sphenoid bone*, by part of the suture of this name; at their lower edge, to the *os temporum*, by the squamous suture, and its posterior *additamentum*; behind, to the *os occipitis*, or *os triquetra*, by the lambdoid suture; and above, to one another, by the sagittal suture.

They have no particular uses besides those mentioned in the description of their several parts, except what are included in the account of the general structure of the *cranium*.

In a child born at the full time, none of the sides of this bone are completed; and there never is a hole in the ossified part of it near to the sagittal suture.

The large unossified ligamentous part of the *cranium* observable between the parietal bones, and the middle of the divided *os frontis* of new-born children, called by the vulgar the *open of the head*, was imagined by the ancients to serve for the evacuation of the superfluous moisture of the brain; and therefore they named

(i) Cowper's *Anatom.* explic. of 90 tab. fig. 2.

named it *bregma* (*l*), or the fountain; sometimes adding the epithet *pulsatilis*, or beating, on account of the pulsation of the brain felt through this flexible ligamento-cartilaginous substance. Hence very frequently the parietal bones are called *os bregmatum*.

The upper middle part of the head of a child, in a natural birth, being what presents itself first at the *os uteri* (*m*), an accoucheur may reach the *bregma* with his finger, when the *os uteri* is a little opened. If the *bregma* is stretched, and the pulsation of the brain is felt through it, the child is certainly alive: But if it is shrivelled and flaccid, without any observable pulsation in it, there is some reason to suspect the child to be very weak, or dead. Those who practise midwifery should therefore examine the state of the *bregma* accurately.

All the *bregma* is generally ossified before seven years of age. Several authors (*n*) say, they have observed it unossified in adults; and physicians, who order the application of medicines at the meeting of the coronal and sagittal sutures, seem yet to think, that a derivation of noxious humours from the *encephalon* is more easily procured at this part than any other of the scull; and that medicines have a greater effect here than elsewhere, in the internal disorders of the head.

OSSA TEMPORUM (*o*), so named, say authors, from the hair's first becoming gray on the temples, and thus discovering peoples ages, are each of them equal and smooth above, with a very thin semicircular edge; which, from the manner of its connection with the neighbouring bones, is distinguished by the name of *os squamosum*.—Behind this the upper part

(*l*) *Palpitans vertex, foliolum, folium, triangularis lacuna.*

(*m*) Burton's Midwifery, § 51.—Smellie's Midwifery, book 1. chap. I. § 5.

(*n*) Bartholin. Anat. reform. lib. 4. cap. 6.—Diemerbroek Anat. lib. 9. cap. 6.—Kerckring. Osteogen. cap. 2.

(*o*) Κορταφων, κορσων, κορρων, λεπιδοειδη, πολυειδη, λιθοειδη, temporalia, lapidosa, membranosa, dura, arecualia, tympanum, armalia, faxea, parietalia.

of the temporal bone is thicker, and more unequal, and is sometimes described as a distinct part, under the name of *pars mammillaris* (*p.*).—Towards the base of the scull, the temporal bone appears very irregular and unequal; and this part, instead of being broad, and placed perpendicularly, as the others are, is contracted into an oblong very hard substance, extended horizontally forwards and inwards, which in its progress becomes smaller, and is commonly called *os petrosum*.

Three external processes of each temporal bone are generally described.—The first placed at the lower and hind part of the bone, from its resemblance to a nipple, is called *mastoïdes*, or *mammillaris*. It is not solid, but within is composed of *cancelli*, or small cells, which have a communication with the large cavity of the ear, the drum; and therefore sounds, being multiplied in this vaulted labyrinth, are increased, before they are applied to the immediate organ of hearing. Into the mastoid process, the *stenomastoïdeus* muscle is inserted; and to its back part, where the surface is rough, the *trachelomastoïdeus*, and part of the *splenius* are fixed.—About an inch farther forward, the second process begins to rise out from the bone; and having its origin continued obliquely downwards and forwards for some way, it becomes smaller; and is stretched forwards to join with the *os male*; they together forming the bony *jugum*, under which the temporal muscle passes. Hence this process has been named *zygomatic* (*a.*). Its upper edge has the strong aponeurosis of the *temporal* muscle fixed into it; and its lower part gives rise to a share of the *masseter*.—The fore part of the base of this process is an oblong tubercle, which in a recent subject is covered with a smooth polished cartilage, continued from that which lines the cavity immediately behind this tubercle.—From the under craggy part of the *os temporum*, the third

(*p.*) Albin. de ossib. sect. 26.

(*a.*) Κεγκός, paris, anæ ossium temporum, ossa arcualia, paria, jugalia, conjugalia.

third process stands out obliquely forwards. The shape of it is generally said to resemble the ancient *stylos scriptorius*: and therefore it is called the *styloid* process (*b*). Some authors (*c*) however contend, that it ought to be named *steloid*, from its being more like to a pillar. Several muscles have their origin from this process, and borrow one half of their name from it; as *stylo-glossus*, *stylo-hyoideus*, *stylo-pharyngeus*; to it a ligament of the *os hyoides* is sometimes fixed; and another is extended from it to the insides of the angle of the lower jaw. This process is often, even in adults, not entirely ossified, but is ligamentous at its root, and sometimes is composed of two or three distinct pieces.—Round the root of it, especially at the fore-part, there is a remarkable rising of the *os petrosum*, which some have esteemed a process; and, from the appearance it makes with the *styliform*, have named it *vaginalis*.—Others again have, under the name of *auditory* process, reckoned among the external processes that semicircular ridge, which, running between the root of the *mastoid* and *zygomatic* processes, forms the under part of the external *meatus auditorius*.

The sinuosities or depressions on the external surface of each *os temporum*, are these:—A long *fosca* at the inner and back part of the root of the mammary process, where the posterior head of the *digastric* muscle has its origin.—Immediately before the root of the *zygomatic* process, a considerable hollow is left, for lodging the *crotaphite* muscle.—Between the *zygomatic*, *auditory*, and *vaginal* processes, a large cavity is formed; through the middle of which, from top to bottom, a fissure is observable, into which part of the ligament that secures the articulation of the lower jaw with this bone is fixed. The fore-part of the cavity being lined with the same cartilage which covers the tubercle before it, receives the *condyle* of the jaw; and

(*b*) Γραπτοειδη, βελονοειδη, πλικτρον, *os calaminum*, *sagittale*, *clavale*, *acuale*, *calcar capititis*.

(*c*) Galen, de usu part. lib. 2. cap 4.—Fallop. observ. anatom.

and in the back part a small share of the parotid gland and a cellular fatty substance, are lodged.—At the inside of the root of the *styloid apophysis*, there is a thimble-like cavity, where the beginning of the internal jugular vein, or end of the lateral sinus is lodged.—And as the sinuses of the two sides are frequently of unequal size; so one of these cavities is as often larger than the other (*d*).—Round the external *meatus auditorius*, several sinuosities are formed for receiving the cartilages and ligaments of the ear, and for their firm adhesion.

The holes that commonly appear on the outside of each of these bones, and are proper to each of them, are five.—The first, situated between the *zygomatic* and *mastoid* processes, is the orifice of a large tunnel-like canal, which leads to the organ of hearing; therefore is called *meatus auditorius externus* (*e*).—The second gives passage to the *portio dura* of the seventh pair of nerves, and from its situation between the *mastoid* and *styloid* processes, is called *foramen stylo-mastoideum* (*g*).—Some way before, and to the inside of the *styloid* process, is the third hole; the canal from which runs first upwards, then forwards, and receives into it the internal *carotid* artery, and the beginning of the intercostal nerve; where this canal is about to make the turn forwards, one, or sometimes two very small holes go off towards the cavity of the ear, called *tympanum*; through these *Valsalva* (*b*) affirms the proper artery or arteries of that cavity are sent.—On the anterior edge of this bone, near the former, a fourth hole is observable, being the orifice of a canal which runs outwards and backwards, in a horizontal direction, till it terminates in the *tympanum*. This, in the recent subject, is continued forward and inward, from the parts which I mentioned just now as its orifice in the skeleton, to the side of

the

(*a*) Hunaud Mem. de l'acad. des sciences, 1730.

(*c*) Πόρος της ακοης, στην των ατων, fenestra aurium.

(*g*) Aquaeductus Fallopii.

(*b*) De aure humana, cap 2. § 22. et tab. 7. fig. 1.

the nostrils; being partly cartilaginous, and partly ligamentous. The whole canal is named, *Iter a palato ad aurem, or Eustachian tube.*—On the external side of the bony part of this canal, and a-top of the chink in the cavity that receives the *condyle* of the lower jaw, is the course of the little nerve said commonly to be reflected from the lingual branch of the fifth pair, till it enters the *tympanum*, to run across this cavity, and to have the name of *chorda tympani*.—The *fifth hole* is very uncertain, appearing sometimes behind the *mastoid* process; sometimes it is common to the temporal and occipital bones; and in several skulls there is no such hole. The use of it, when found, is for the transmission of a vein from the external teguments to the lateral *sinus*: But, in some subjects, a branch of the occipital artery passes through this hole, to serve the back part of the *dura mater*; in others, I have seen two or three such holes: But they are oftener wanting than found. And we may, once for all, in general remark, That the largeness, number, situation, and existence of all such holes, that for the most part allow only a passage for veins from without to the internal receptacles, are very uncertain.

The internal surface of the *osseum temporum* is unequal; the upper circular edge of the squamous part having numerous small ridges and furrows for its conjunction with the parietal bones; and the rest of it is irregularly marked with the convolutions of the middle part of the brain, and with furrows made by the branches of the arteries of the *dura mater*.

From the under part of this internal surface, a larger transverse hard craggy protuberance runs horizontally inwards and forwards, with a sharp edge above, and two flat sides, one facing obliquely forwards and outwards, and the other as much backwards and inwards. To the ridge between these two sides, the large lateral process of the *dura mater* is fixed.

Sometimes a small bone, akin to the *sesamoid*, is found

found between the small end of this *pétrous process* and the *sphenoid bone* (*a*).

Towards the back part of the inside of the *os temporum*, a large deep *fossa* is conspicuous, where the *lateral sinus* lies; and frequently on the top of the *petrous ridge*, a furrow may be observed, where a small *sinus* is situated.

The internal proper *foramina* of each of these bones are, *first*, the internal *meatus auditorius* in the posterior plain side of the *petrous process*. This hole soon divides into two; one of which is the beginning of the *aquæduct* of *Fallopis*; the other ends in several very small canals (*b*) that allow a passage to the branches of the *portio mollis* of the seventh pair of nerves, into the *vestibule* and *cochlea*. Through it also an artery is sent, to be distributed to the organ of hearing.—The *second* hole, which is on the anterior plain side of the craggy process, gives passage to a reflected branch of the second branch of the fifth pair of nerves, which joins the *portio dura* of the auditory nerve, while it is in the *aquæduct* (*c*), small branches of blood-vessels accompanying the nerves or passing through smaller holes near this one.—The passage of the cutaneous vein into the *lateral sinus*, or of a branch of the *occipital artery*, is seen about the middle of the large *fossa* for that *sinus*; and the orifice of the canal of the *carotid artery* is evident at the under part of the point of the *petrous process*.

Besides these proper holes of the temporal bones which appear on their external and internal surfaces, there are two others in each side that are common to this bone and to the *occipital* and *sphenoidal* bones; which shall be mentioned afterwards in the description of these bones.

The upper round part of the *squamous bones* is thin, but equal; while the low *petrous* part is thick and

(*a*) *Riolan. Comment. de ossib. cap. 32.*—*Winslow Exposition anatomique du corps humain, traité des os secs, § 266.*

(*b*) *Valsalv. De aure humana, cap. 3. § II.*

(*c*) *Valsalv. de aure, cap. 3. § 10.*

and strong, but irregular and unequal, having the distinction of tables and *diploe* confounded, with several cavities, processes, and bones within its substance, which are parts of the organ of hearing. That a clear idea may be had of this beautiful, but intricate organ, anatomists generally choose to demonstrate all its parts together. I think the method good; and therefore, since it would be improper to insert a complete treatise on the ear here, shall omit the description of the parts contained within the *os petrosum* of the skeleton.

The temporal bones are joined above to the parietal bones by the squamous sutures, and their posterior *additamenta*: Before, to the *sphenoid* bone by the suture of that name; to the cheek-bones by the *zygomatic* sutures: Behind, to the *occipital* bone, by the *lambdoid* suture and its *additamenta*; and they are articulated with the *lower jaw*, in the manner which shall be described when this bone is examined.

The purposes which these two bones serve, are easily collected, from the general use of the *cranium*, and from what has been said in the description of their several parts.

In an infant, a small fissure is to be observed between the thin, upper part, and the lower craggy part of each of these bones; which points out the recent union of these parts.—Neither *mastoid* nor *styloid* processes are yet to be seen.—Instead of a bony funnel-like external *meatus auditorius*, there is only a smooth bony ring, within which the membrane of the drum is fastened.—At the entry of the *Eustachian tube*, the side of the *tympanum* is not completed.—A little more outward than the internal auditory canal, there is a deep pit, over the upper part of whose orifice the interior semicircular canal of the ear is stretched; and some way below this, the posterior semicircular canal also appears manifestly.

OS OCCIPITIS (d), so called from its situation,

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(d) *Ivov*, *basilare*, *proræ*, *memoriae*, *pixidis*, *fibrosum*, *nervosum*, *lambde*.

tion, is convex on the outside, and concave internally. Its figure is an irregular square, or rather *rhomboïd*; of which the angle above is generally a little rounded; the two lateral angles are more finished, but obtuse; and the lower one is stretched forward in form of a wedge, and thence is called by some the *cuneiform* process.—If one would, however, be very nice in observing the several turns which the edges of the *os occipitis* make, five or seven sides, and as many angles of this bone might be described.

The external surface is convex, except at the *cuneiform* apophyse, where it is flattened. At the base of this triangular process, on each side of the great hole, but more advanced forwards than the middle of it, the large oblong protuberances, named the *condyles*, appear, to serve for the articulation of this bone with the first *vertebra* of the neck. The smooth surface of each of these *condyloid* processes is longest from behind forwards, where, by their oblique situation, they come much nearer to each other than they are at their back part. Their inner sides are lower than the external, by which they are prevented from sliding to either side out of the cavities of the first *vertebra* (e). In some subjects each of these plain smooth surfaces seems to be divided by a small rising in its middle; and the lower edge of each condyle, next the great *foramen*, is discontinued about the middle, by an intervening notch: Whence some (f) alledge, that each of these *apophyses* is made up of two protuberances.—Round their root a small depression and spongy roughness is observable, where the ligaments for surrounding and securing their articulations adhere.—Though the motion of the head is performed on the condyles, yet the centre of gravity of that globe does not fall between them, but is a good way further forward; from which mechanism it is evident, that the muscles which pull the head back, must be in a constant state of contraction; which

(e) Galen. de usu part. lib. 12. cap. 7.

(f) Diemerbrock Anat. lib. 9. cap. 6.

which is stronger than the natural contraction of the proper flexors, else the head would always fall forwards, as it does when a man is asleep, or labours under a palsy, as well as in infants, where the weight of the head far exceeds the proportional strength of these muscles. This seeming disadvantageous situation of the condyles, is however of good use to us, by allowing sufficient space for the cavities of the mouth and *fauces*, and for lodging a sufficient number of muscles, which commonly serve for other uses; but may at pleasure be directed to act on the head, and then have an advantageous lever to act with, so as to be able to sustain a considerable weight appended, or other force applied, to pull the head back.

Somewhat more externally than the *condyles*, there is a small rising and semilunated hollow in each side, which make part of the holes, common to the *occipital* and *petrous* bones.—Immediately behind this, on each side, a scabrous ridge is extended from the middle of the *condyle*, towards the root of the *maffoid* process. Into this ridge the *musculus lateralis*, commonly ascribed to *Fallopianus*, is inserted.—About the middle of the external convex surface, a large arch runs cross the bone; from the upper lateral parts of which the *occipital* muscles have their rise; to its middle the *trapezii* are attached: And half way between this and the great hole, a lesser arch is extended.—In the hollows between the middle of these arches the *complexi* are inserted; and in the depressions more external and further forward than these, the *splenii* are inserted.—Between the middle of the lesser arch and the great hole, the little hollow marks of the *recti minores* appear; and on each side of these the fleshy insertions of the *obliqui superiores* and *recti majores* make depressions.—Through the middle of the two arches a small sharp *spine* is placed, which serves as some sort of partition between the muscles of different sides, or rather is owing to the action of the muscles depressing the bone on each side of it, while this part is free from their compression.—These

prints of the muscles on this bone are very strong and plain in some subjects, but are not so distinct in others.—All round the great *foramen*, the edges are unequal, for the firmer adhesion of the strong circular ligament, which goes thence to the first *vertebra*.—One end of each *lateral* or *moderator* ligament of the head, is fixed to a rough surface at the fore part of each *condyle*, and the *perpendicular* one is connected to a rough part of the edge of the great hole between the two *condyles*.—Immediately before the *condyles*, two little depressions are made in the external surface of the *cuneiform* process, for the insertion of the *recti anteriores minores* muscles which are unjustly ascribed to *Cowper*: And still further forward, near the *sphenoid* bone, are two other such depressions, for the reception of the *recti anteriores majores*.—When we consider the size of the prints of muscles on the *occipital* bone, before and behind its *condyles*, and, at the same time, compare their distances from these centres of motion of the head, we must see how much stronger the muscles are which pull the head backwards, than those are which bend it forward; and how much greater force the former acquire by the long lever they act with, than the latter which are inserted so near the *condyles*. This great force in the extensor muscles is altogether necessary, that they might not only keep the head from falling forward in an erect posture, but that they might support it when we bow forward in the most necessary offices of social life, when the weight of the head comes to act at right angles on the *vertebrae* of the neck, and obtains a long lever to act with.

On the inner surface of the *os occipitis* we see two ridges; one standing perpendicular, the other running horizontally across the first. The upper part of the perpendicular limb of the cross, to which the *falx* is fixed, is hollowed in the middle, or often on one side, for the reception of the *superior longitudinal sinus*, and the lower part of it has the small or third process of the *dura mater* fastened to it, and is sometimes

times hollowed by the *occipital sinus*. Each side of the horizontal limb is made hollow by the lateral sinuses inclosed in the transverse process of the *dura mater*; the *fossa* in the right side being generally a continuation of the one made by the longitudinal sinus in the perpendicular limb, and therefore is larger than the left one (g).—Round the middle of the cross there are four large depressions separated by its limbs; the two upper ones being formed by the back part of the brain, and the two lower ones by the *cerebellum*.—Farther forward than the last mentioned depressions, is the lower part of the *fossa* for the lateral *sinus* on each side.—The inner surface of the cuneiform apophysis is made concave for the reception of the *medulla oblongata*, and of the *basilar artery*.—A furrow is made on each side, near the edges of this process, by a *sinus* of the *dura mater*, which empties itself into the lateral *sinus* (h).

The holes of this bone are commonly five proper, and two common to it and to the *temporal* bones.—The first of the proper holes, called *foramen magnum* (i), from its size, is immediately behind the wedge-like process, and allows a passage to the *medulla oblongata*, *nervi accessoriis*, to the vertebral arteries, and sometimes to the vertebral veins.—At each side of this great hole, near its fore part, and immediately above the condyles, we always find a hole, sometimes two, which soon unite again into one that opens externally; through these the ninth pair of nerves go out of the skull.—The fourth and fifth holes pierce from behind the *condyle* of each side into the *fossa* of the lateral *sinuses*; they serve for the passage of the cervical veins to these *sinuses*. Often one of these holes is wanting, sometimes both, when the veins pass through the great *foramen*.—Besides these five, we frequently meet with other holes near the edges of this bone, for the transmission of veins;

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but

(g) Morgagn. Advers. anat. 6. animad. 2.

(h) Albin. de ossib. § 65.

(i) Rachitidis medullæ spinalis.

but their number and diameter are very uncertain. The two common *foramina* are the large irregular holes, one in each side, between the sides of the *cuneiform* process, and the edges of the *petrous* bones. In a recent subject, a strong membrane runs cross from one side to the other of each of these holes; in some heads I have seen this membrane ossified, or a bony partition dividing each hole; and in the greater number of adult skulls, there is a small sharp-pointed process stands out from the *os petrosum*, and a more obtuse rising in the occipital bone, between which the partition is stretched. Behind this partition, where the largest space is left, the *lateral sinus* has its passage; and before it the eighth pair of nerves and *accessorius* make their exit out of the skull; and some authors say, an artery passes through this hole, to be bestowed on the *dura mater*.

The *occipital* bone is among the thickest of the *cranium*, though unequally so; for it is stronger above, where it has no other defence than the common teguments, than it is below, where, being pressed by the lobes of the brain and *cerebellum* on one side, and by the action of the muscles on the other, it is so very thin, as to be diaphanous in many skulls: But then these muscles ward off injuries, and the ridges and spines, which are frequent here, make it sufficiently strong to resist ordinary forces. The tables and *diploe* are tolerably distinct in this bone, except where it is so thin as to become diaphanous.

The *occipital* bone is joined above to the *os parietalia* and *triquetra* when present, by the *lambdoid* suture;—laterally to the *temporal* bones, by the *aditamenta* of the *lambdoid* suture;—below to the *sphenoid* bone, by the end of its *cuneiform* process, in the same way that epiphyses and their bones are joined: For in children, a ligamentous cartilage is interposed between the *occipital* and *sphenoid* bones, which gradually turns thinner, as each of the bones advances, till their fibres at last run into each other; and, about sixteen or eighteen years of age, the union

of

of these two bones becomes so intimate, that a separation cannot be made without violence.—The *os occipitis* is joined by a double articulation to the first *vertebra* of the neck, each condyle being received into a superior oblique process of that *vertebra*. What motion is allowed here, we shall consider afterwards, where the *vertebrae* are described.

The uses of this bone appear from the preceding description, and therefore need not be repeated.

An infant born at the full time, has this bone divided, by unossified cartilages, into four parts.—The first of these is larger than the other three, is of a triangular shape, and constitutes all the part of the bone above the great *foramen*. Generally fissures appear in the upper part and sides of this triangular bone, when all the cartilage is separated by maceration; and sometimes little distinct bones are seen towards the edges of it.—The second and third pieces of this bone are exactly alike, and situated on each side of the great *foramen*; from which very near the whole condyles are produced; and they are extended forwards almost to the fore part of the hole for the ninth pair of nerves.—The fourth piece is the cuneiform process, which forms a small share of the great hole, and of these for the ninth pair of nerves, and of the condyles: Betwixt it and the *sphenoid* bone, a cartilage is interposed.

Of the eight bones which belong to the *cranium*, there are only two which are not yet described, *viz.* the *ethmoid* and *sphenoid*. These we already mentioned, in complaisance to the generality of writers on this subject, as bones common to the *cranium* and face, because they enter into the composition of both: But the same reason might equally be used for calling the frontal bone a common one too. I shall, however, pass any idle dispute about the propriety of ranging them, and proceed to examine the structure of the bones themselves.

OS ETHMOIDES (*k*), or the sieve-like bone,
has

(*k*) *Cribriiforme*, *εποχρόιδης*, *spongiforme*, *cristatum*.

has got its name from the great number of small holes with which that part of it first taken notice of is pierced. When this bone is entire, the figure of it is not easily described; but, by a detail of its several parts, some idea may be afforded of the whole; and therefore I shall distinguish it into the *cibriiform lamella* with its process, the *nasal lamella*, *cellulae*, and *osse spongiosa*.

The thin horizontal *lamella*, is all (except its back part) pierced obliquely by a great number of small holes, through which the filaments of the olfactory nerves pass. In a recent subject, these holes are so closely lined by the *dura mater*, that they are much less conspicuous than in the *skeleton*.—From the middle of the internal side of this plate, a thick process rises upwards, and, being highest at the fore part, gradually becomes lower, as it is extended backwards. From some resemblance which this process was imagined to have to a cock's comb, it has been called *crista galli* (*I*). The *falx* is connected to its ridge, and to the unperforated part of the *cibriiform plate*.—When the *crista* is broke, its base is sometimes found to be hollow, with its cavity opening into the nose (*m*).—Immediately before the highest part of this process, is the blind hole of the *frontal bone*, which, as was formerly remarked, is often in a good measure formed by a notch in the fore part of the root of the *crista*.

From the middle of the outer surface of the *cibriiform lamella*, a thin solid plate is extended downwards and forwards, having the same common base with the *crista galli*. Generally it is not exactly perpendicular, but is inclined to one side or other, and therefore divides the cavity of the nose unequally. Its inclination to one side, and flexure in the middle, is sometimes so great, that it fills up a large share of one of the nostrils, and has been mistook for a *polypus* there.—It is thin at its rise, and rather still thinner

(*I*) *Verruca praedura, septum ossis spongiosi.*

(*m*) *Palsyn Anat. chir. tr. 4. chap. 15.*

thinner in its middle; yet afterwards, towards its lower edge, it becomes thicker, that its conjunction with the bones and middle cartilage of the nose might be firmer.

At a little distance from each side of this external process, a cellular and spongy bony substance depends from the cribriform plate. The number and figure of the cells in this irregular process of each side, are very uncertain, and not to be represented in words; only the cells open into each other, and into the cavity of the nose: The uppermost, which are below the aperture of the frontal *sinuses*, are formed like funnels.—The outer surface of these cells is smooth and plain, where this bone assists in composing the orbit; at which place, on each side, it has got the name of *os planum*; on the upper edge of which, a small notch or two may sometimes be observed, which go to the formation of the internal orbital holes; as was remarked in the description of the frontal bone.

Below the cells of each side, a thin plate is extended inwards, and then, bending down, it becomes thick and of a spongy texture.—This spongy part is triangular, with a straight upper edge placed horizontally, an anterior one slanting from above, downwards and forwards, and with a pendulous convex one below.—The upper and lower edges terminate in a sharp point behind.—The side of this pendulous spongy part next to the *septum narium* is convex, and its external side is concave.—These two processes of the *ethmoid* bone have got the name of *os spongiosa*, or *turbinata superiore*, from their substance, figure, and situation.—All the prominences, cavities, and meanders of this *ethmoid* bone, are covered with a continuation of the membrane of the nostrils, in a recent subject.—Its horizontal cribriform plate is lodged between the orbital processes of the *frontal* bone, to which it is joined by the *ethmoid* suture, except at the back-part, where it is connected with the *cuneiform* bone, by a suture common to both these bones, though it is generally esteemed part of the *sphenoidal*.—Where the *os*

osse plana are contiguous to the frontal bone within the orbit, their conjunction is reckoned part of the transverse suture.—Farther forward than the *osse plana*, the cells are covered by the *osse unguis*, which are not only contiguous to these cells, but cannot be separated from them, without breaking the bony substance; and therefore, in justice, those bones ought to be demonstrated as part of the *ethmoid* bone.—Below the *osse unguis* and *plana*, these cells and *osse spongiosa* are overlapped by the *maxillary* bones.—The cellular part of each *palate* bone is contiguous to each *os planum* and cells backwards.—The lower edge of the nasal perpendicular plate is received into the furrow of the *vomer*:—Its posterior edge is joined to the fore-part of the *processus azygos* of the *sphenoid* bone.—Its upper edge joines the *nasal* process of the *frontal* and *nasal* bones, and its anterior one is connected to the middle cartilage of the nose.

From all which, the uses of this bone are evident, viz. to sustain the anterior lobes of the brain; to give passage to the olfactory nerves, and attachment to the *falk*; to enlarge the organ of smelling, by allowing the membrane of the nose a great extent; to straiten the passage of the air through the nose, by leaving only a narrow winding canal, on the sensible membranous sides of which the substances conveyed along with the air must strike; to form part of the orbit of the eyes and *septum narium*; while all its parts are so light as not to be in hazard of separating by their weight; and they are so thin, as to form a large surface, without occupying much space. This brittle substance, however, is sufficiently protected from external injuries by the firm bones which cover it.

If this bone is seized on by any corroding matter, we may easily conceive what destruction may ensue. Hence it is, that an *ozaena* is difficult to cure; and that, in violent scurvies, or in the *lues venerea*, the fabric of the nose, the eyes, and life itself are in danger.—The situation of the nasal plate may shew us, how

how dangerous a fracture of the bones of the nose may be, when made by a force applied to their middle fore part, of a person in whom this nasal plate is perpendicular.

The *ethmoid* bone of ripe children is divided into two, by a perpendicular cartilage, which, when ossified, is the *crista galli*, and nasal plate: but its other parts are ossified and complete.

OS SPHENOIDES *, or wedge-like bone, so called because of its situation in the middle of the bones of the *cranium* and face, is of such an irregular figure, that I know not any thing to which it may be likened, unless, perhaps, it bear some faint resemblance to a bat with its wings extended.

When we view the external surface of the *os sphenoïdes*, two or three remarkable processes from each side of it may be observed, which are all of them again subdivided.—The first pair is the two large lateral processes or wings; the upper part of each of which is called the *temporal process*, because they join with the temporal bones in forming the temples, and the seat for some share of the *crotaphite* muscles. That part of the wings which juts out towards the inside, somewhat lower than the temporal *apophyses*, and is smooth and hollowed, where it makes up part of the orbit, is thence named *orbitar processes*. Behind the edge, separating these two processes, there is often a small groove, made by a branch of the superior maxillary nerve, in its passage to the temporal muscle. The lowest and back part of each wing, which runs out sharp to meet the *ossa petrosa*, has been styled the *spinous process*: From near the point of which a sharp pointed process is frequently produced downwards, which some call *styloid*, that affords origin to the *ptery-staphylinus externus* muscle. From this styloid process a very small groove is extended along the edge of the bone to the hollow at the root of the internal plate of the following processes, which forms

* Cuneiforme, *πολυμορφον*, multiforme, paxillum, cibratum patati, colatorii, cavilla, basilare.

forms part of the *Eustachian* tube (*a*).—The second pair of external processes of the *cuneiform* bone is the two which stand out almost perpendicular to the base of the scull. Each of them has two plates, and a middle *fossa* facing backwards, and should, to carry on our comparison, be likened to the bat's legs, but are commonly said to resemble the wings of that creature; and therefore are named *pterygoid* or *aliform** processes. The external plates are broadest, and the internal are longest. From each side of the external plates the *pterygoid* muscles take their rise. At the root of each internal plate, a small hollow may be remarked, where the *musculus pteryostaphylinus internus*, or *circumflexus palati* rises, and some share of the cartilaginous end of the *Eustachian* tube rests; and, at the lower end of the same plate, is a hook-like rising or process, round which the tendon of the last-named muscle, plays as on a pulley. From the edge of the external plate some small sharp spikes stand out; but their number and bulk are uncertain. To these another pair may be added, to wit, the little triangular thin process, which comes from each side of the body of the *sphenoid* bone, where the *pterygoid* processes are rising from it, and are extended over the lower part of the aperture of the *sinus* as far as to join the *ethmoid* bone, while their body hangs down into the *nares* (*b*).—Besides these pairs of processes, there is a sharp ridge which stands out from the middle of its base: Because it wants a fellow, it may be called *processus azygos*. The lower part of this process, where it is received into the *vomer*, is thick, and often not quite perpendicular, but inclining more to one side than the other. The fore part of this process, where it joins the nasal plate of the *os ethmoides*, is thin and straight. These two

(*a*) Winslow Exposition anatomique du corps humain, traité des os secs, § 233.

* *Naviculares*.

(*b*) Albin. Tab. off. 5. fig 2. 6. A A.—Bertin Mem. de l'acad. des sciences, 1744.—Sue, planche viii. fig. 2. 3. 4. 5. 6.

two parts have been described as two distinct processes by some.

The depressions, sinuosities, and *fossae*, on the external surface of this *sphenoid* bone, may be reckoned up to a great number, *viz.* two on the temporal *apophyses* where the *crotaphytic* muscles lodge.—Two on the *orbital* processes, to make way for the globes of the eyes.—Two between the *temporal* and *spinous* processes, for receiving the temporal bones.—Two between the plates of the *pterygoid* processes, where the *musculi pterygoidei interni* and *pterygo-staphylini interni* are placed.—Two between the *pterygoid* and *orbital* processes, for forming the holes common to this and to the *cheek* and *maxillary* bones.—Two on the lower ends of the *aliform* processes, which the *palate* bones enter into.—Two at the roots of the *temporal* and *pterygoid* processes, where the largest share of the external *pterygoid* muscles have their rise.—Two at the sides of the *processus azygos*, for forming part of the nose, &c.

What I described under the name of *temporal* and *spinous processes* on the outside of the scull, are likewise seen on its inside, where they are concave, for receiving part of the brain; and commonly three *apophyses* on the internal surface of the *sphenoid* bone are only mentioned. Two rising broad from the fore-part of its body, become smaller as they are extended obliquely backwards.—The third standing on a long transverse base, near the back-part of the body of this bone, rises nearly erect, and of an equal breadth, terminating often in a little knob on each side. The three are called *clinoid*, from some resemblance which they were thought to have to the supporters of a bed. Sometimes one or both the anterior *clinoid* processes are joined to the sides of the posterior one, or the body of the bone itself.—From the roots of the anterior *clinoid* processes the bone is extended on each side outwards and forwards, till it ends in a sharp point, which may have the name of the *transverse spinous processes*.—Between, but a little

farther back than the two anterior *clinoid* processes, we see a protuberance considerably smaller than the posterior *clinoid* process, but of its shape.—Another process from between the transverse processes, often forces itself forwards into the *os ethmoides*.

Within the scull, there are two sinuosities in the internal part of each wing of the *sphenoid* bone, for receiving the middle part of the brain.—One between the transverse spinous processes, for lodging the part of the brain where the *crura medullae oblongatae* are.—Immediately before the third or middle *clinoid* process, a single pit generally may be remarked, from which a *fossa* goes out on each side to the holes through which the optic nerves pass. The pit is formed by the conjoined optic nerves; and in the *fossa* these nerves are lodged, as they run divided within the scull.—Between that third protuberance and the posterior *clinoid* process, the larger pit for the *glandula pituitaria* may be remarked. This cavity, because of its resemblance to a *Turkish saddle*, is always described under the name of *sella Turcica*, or *ephippium*.—On the sides of the posterior *clinoid* process, a *fossa* may be remarked, that stretches upwards, then is continued forwards along the sides of the *sella Turcica*, near to the anterior *clinoid* processes, where a pit on each side is made. These *fossa* point out the course of the two internal *carotid* arteries, after they have entered the scull.—Besides all these, several other *fossa* may be observed, leading to the several holes, and imprinted by the nerves and blood-vessels.

The holes on each side of the *os sphenoides* are six proper, and three common.—The first is the round one immediately below the anterior *clinoid* processes, for the passage of the optic nerve, and of the branch of the internal *carotid* artery that is sent to the eye.—The second is the *foramen lacerum*, or large slit between the transverse spinous and orbital processes: The interior end of which slit is large; and, as it is extended outwards, it becomes narrower. The outer end of it is formed in the *os frontis*; and therefore this

this might be reckoned among the common *foramina*. Through it the third, fourth, the first branch of the fifth, and the greater share of the sixth pair of nerves, and an artery from the internal carotid, go into the orbit. Sometimes a small branch of the external carotid enters near its end, to be distributed to the *dura mater* (*a*) ; and a vein, some call it the *venous duct*, or, *Nuck's aquæduct*, returns through it to the cavernous *sinus*.—The third hole, situated a little below the one just now described, is called *rotundum*, from its shape. It allows passage to the second branch of the fifth pair of nerves, or superior maxillary nerve, into the bottom of the orbit. The fourth is the *foramen ovale*, about half an inch behind the round hole. Through it the third branch of the fifth pair, or inferior maxillary nerve, goes out ; and sometimes a vein from the *dura mater* passes out here (*b*).—Very near the point of the spinous process is the fifth hole of this bone : It is small and round, for a passage to the largest artery of the *dura mater*, which often is accompanied with a vein. The sixth proper hole (*c*) cannot be well seen, till the cuneiform bone is separated from all the other bones of the *cranium*; for one end of it is hid by a small protuberance of the internal plate of the *pterygoid* process, and by the point of the *processus petrosus* of the *temporal* bone. Its canal is extended above the inner plate of the *pterygoid* process ; and where it opens into the cavity of the nose, it is concealed by the thin laminous part of the *palate* bone. Through it a considerable branch of the second branch of the fifth pair of nerves is reflected.—Often in the middle of the *sella Turcica* a small hole or two pierce as far as the cellular substance of the bone ; and sometimes at the sides of this *sella*, one or more small holes penetrate into the *sphenoidal sinuses*.

H 2

(*a*) Winslow Exposition anatomique du corps humain, traité des artères, § 60. et de la tête, § 26.

(*b*) Ingraff. Commentar. in Galen. de ossib. lib. I. comment. 8.

(*c*) Vesal. Anat. lib. I. cap. 12.—Eustach. tab. 46. fig. 13. & 16.—Vidus Vidius Anat. lib. 2. cap. 2. explicat. tab. 5. & tab. 5. fig. 8. & 10. lit. O.

sinuses. These observations afforded some anatomists (a) an argument of weight in their days in defence of Galen (b), who asserted the descent of the *pituita* that way into the *sinuses* below.

The first of the common holes is that unequal fissure at the side of the *sella Turcica*, between the extreme point of the *os petrosum* and the *spinous process* of the cuneiform bone. This hole only appears after the bones are boiled; for in a recent subject its back part is covered by a thin bony plate that lies over the internal carotid artery, and further forward it is filled with a cartilaginous ligament, under which the cartilaginous part of the *Eustachian tube* is placed: It was by this passage that the ancients believed the *slimy matter* was conveyed from the eumuncitory of the brain, the *glandula pituitaria*, to the *fauces*.—The second common hole is the large discontinuation of the external side of the orbit, left between the orbital processes of the cuneiform bone, the *os maxillare*, *mallei*, and *palati*. In this large hole the fat for lubricating the globe of the eye and temporal muscle is lodged, and branches of the superior maxillary nerve, with small arteries from the carotid and veins pass.—The third hole is formed between the base of this bone and the root of the orbital process of the palate bone of each side. Through this a branch of the external carotid artery, and of the second branch of the fifth pair of nerves, are allowed a passage to the nostrils, and a returning vein accompanies them. Sometimes, however, this hole is proper to the palate bone, being entirely formed out of its substance.

Under the *sella Turcica*, and some way farther forward, but within the substance of the *sphenoid* bone, are two *sinuses*, separated by a bony plate. Each of them is lined with a membrane, and opens into the upper and back-part of each nostril by a round hole, which is at their upper fore-part. This hole is not formed

(a) Jac. Sylv. Calumniae secundæ amolitio.—Laurent. Hist. Anat. lib. 2. quest. 11.

(b) Galen De usu part. lib. 2. cap. I.

formed only by the *os sphenoides*, which has an aperture near as large as any transverse section of the *sinus*, but also by the *palate* bones which are applied to the fore-part of these *sinuses*, and close them up, that hole only excepted, which was already mentioned. Frequently the two *sinuses* are of unequal dimensions, and sometimes there is only one large cavity, with an opening into one nostril. These cavities are likewise said (*a*) to be extended sometimes as far back as the great *foramen* of the *occipital* bone. In other subjects they are not to be found, when the bone is composed of large cells (*b*). Some (*c*) mention a cavity within the partition of the *sinuses*; but it is small.—The *sphenoidal sinuses* serve the same uses as the frontal do.

As this bone is extremely ragged and unequal, so its substance is of very different thickness, being in some places diaphanous; in others it is of a middle thickness, and its middle back-part surpasses the greatest share of the *cranium* in thickness.

The *os sphenoides* is joined, by its wings, to the *parietal* bones above, to the *os frontis* and *os malarum* before, to the *temporal* bones behind;—by the fore-part of its body and spinous processes, to the *frontal* and *ethmoid* bones;—by its back-part, behind the two *sinuses*, to the *occipital*, where it looks like a bone with the *epiphyses* taken off, and, as was formerly observed in the description of the *occipital* bone, it cannot be separated without violence in adults;—to the *palate* bones, by the ends of the *pterygoid* processes, and still more by the fore-part of the internal plates of the *pterygoid* processes, and of the *sinuses*;—to the *maxillary* bones, by the fore-part of the external *pterygoid* plates;—to the *vomer* and nasal plate of the *os ethmoides*, by the *processus azygos*. All these conjunctions, except the last, which is a *synchondrosis*, are said to be by the suture proper to this bone; though it is at first sight evident,

H 3

that

(*a*) Albim de ossib. § 39.

(*b*) Vesal. lib. 1. cap. 6.

(*c*) Id. ibid.

that several other sutures, as the *transverse, ethmoidal, &c.* are confounded with it.

We see now how this bone is joined to all the bones of the *cranium*, and to most of the upper jaw; and therefore obtained the name of the *wedge-like bone*.

The uses are so blended with the description, as to leave nothing new to be added concerning them.

The *sphenoidal* bone is almost compleat in a *fœtus* of ninth months; only the great *ala* separate after maceration from the body of the bone.—The *processus azygos* is very large and hollow;—the thin triangular processes are not ossified;—the internal surface of the body is unequal and porous;—the *sinuses* do not appear.

Whoever is acquainted with each bone of the *cranium*, can, without difficulty, examine them as they stand united, so as to know the shapes, sizes, distances, &c. of their several parts, and the forms, capacities, &c. of the cavities formed by them, which is of great use towards understanding the anatomy of the parts contiguous to, contained within, or connected to them. Such a review is necessary, after considering each class of bones. Thus the orbits, nostrils, mouth, face, head, spine, *thorax*, *pelvis*, trunk, extremities, and skeleton, ought likewise to be examined.

The *FACE* is the irregular pile of bones, composing the fore and under part of the head, which is divided, by authors, into the upper and lower *maxilla* or jaws.

The *superior maxilla* (*d*) is the common designation given to the upper immoveable share of the face; though, if we would follow *Celsus* (*e*), we should apply the word *maxilla* to the lower jaw only, and the name *mala* to this upper jaw. In complaisance to prevailing custom, I shall, however, use the terms as now commonly employed. The shape of the superior jaw cannot easily be expressed; nor is it necessary,

(d) Σιαγαν, γενος, mandibula.

(e) Lib. 8. cap. I.

ry, provided the shape and situation of all the bones which compose it are described. It is bounded above by the transverse suture, behind by the fore-part of the *sphenoid bone*, and below by the mouth.

The upper jaw consists of six bones on each side, of a thirteenth bone which has no fellow, placed in the middle, and of sixteen teeth. The thirteen bones are, two *osse nasi*, two *osse unguis*, two *osse malarum*, two *osse maxillaria*, two *osse palati*, two *osse spongiosa inferiora*, and the *vomer*.

The *osse nasi* are placed at the upper part of the nose;—the *osse unguis* are at the internal *canthi* of the orbits;—*osse malarum* form the prominence of the cheeks;—*osse maxillaria* form the side of the nose, with the whole lower and fore-part of the upper jaw, and the greatest share of the roof of the mouth;—*osse palati* are situated at the back-part of the palate, nostrils, and orbit;—*osse spongiosa* are seen in the lower part of the *nares*;—and the *vomer* helps to separate these two cavities.

The bones of the *upper jaw* are joined to the bones of the scull by the *synchondrosis* and sutures already described as common to the *cranium* and *face*, and they are connected to each other by *gomphosis* and fifteen sutures.

The *gomphosis* only is where the teeth are fixed in their sockets, and the *synchondrosis* is only where the edges of the *vomer* are joined to other bones.

The sutures are generally distinguished by numbers, which have been differently applied; and therefore I join those (*f*) who prefer the giving names to each, which may be easily contrived from their situation, or from the bones which they connect.

The first is the *anterior nasal* (*g*), which is straight, and placed longitudinally in the middle fore-part of the nose.

The

(*f*) *Vander Linden. Medicin. physiolog. cap. 13. art. 2. sect. 10.*
—*Rolfin. Anat. lib. 2. cap. 25.—Schenk. Schol. pars. sect. ult. par.*
2. cap. 5.

(*g*) *Nasalis recta.*

The second and third are the *lateral nasal* (*b*), which are at each side of the nose, and almost parallel to the first suture.

Each of the two *lacrymal* is almost semicircular, and is placed round the *lacrymal groove*.

The sixth and seventh are the *internal orbital*: each of which is extended obliquely from the middle of the lower side of an orbit to the edge of its base.

The two *external orbitars* are continued, each from the end of the internal orbital, to the under and fore-part of the cheek.

The tenth is the *mystacial*, which reaches only from the lower part of the *septum narium* to between the two middle *dentes incisores*.

The *longitudinal palate* (*i*) future stretches from the middle of the foremost teeth through the middle of all the palate.

The *transverse palate* one (*k*) runs across the palate, nearer the back than the fore-part of it.

Each of the two *palato-maxillary* is at the back part of the side of each nostril.

The fifteenth is the *spinous*, which is in the middle of the lower part of the nostrils. This may perhaps be rather thought a double *schyndelesis*.

The connection of the *osso spongiosa* to the side of each nostril, is so much by a membrane in young subjects, by a sort of hook, and afterwards by concretion or union of substance in adults, that I did not know well how to rank it: But if any chooses to call it a suture, the addition of two *transverse nasal* fusions may be made to those above named.

These sutures of the face (formerly called *harmonia*) have not such conspicuous indentations as those of the scull have; the bones here not having substance enough for forming large indentations, and there being less necessity for security against external injuries, or any internal protruding force, than in the

cranium.—

(*b*) *Nasalis obliqua*.

(*i*) *Laquearis, palataria recta*.

(*k*) *Arcuata, palatina postica*.

cranium.—These sutures often disappear in old people, by the bones running into each other ; which can do little prejudice, because the principal use of the bones being so numerous here, is to allow them to be extended into a proper form.

It is evident, from the manner of the conjunction of these bones, that they can have no motion, except in common with the *cranium*.

The purposes which this pile of bones serves, will be shewn in the description which I am to give of each of them.

OSSA NASI, so named from their situation at the root of the nose, are each of an irregular oblong square figure, being broadest at their lower end, narrowest a little higher than their middle, and becoming somewhat larger at the top, where they are ragged and thickest, and have a curvature forwards, that their connection with the *frontal bone* might be stronger.—These bones are convex externally, and thereby better resist any violence from without ; and they are concave internally, for enlarging the cavity of the nose.

The lower edge of these bones is unequal, and is stretched outwards and backwards, to join the cartilages of the nostrils.—Their anterior side is thick, especially above, and unequal, that their conjunction to each other might be stronger ; and a small rising may be remarked on their inner edge, where they are sustained by the *septum narium*.—Their posterior side, at its upper half, has externally a depression, where it is overlapped some way by the *maxillary bones*, while its lower half covers these bones : By which contrivance, they do not yield easily to pressure applied to their fore-part or sides.

A small hole is frequently to be observed on their external surface, into which two, three, or four holes, which appear internally, terminate for the transmission of small veins ; sometimes the holes go no further than the *cancelli* of the bones.

The

The *nasal bones* are firm and solid, with very few *cells* or *cancelli* in them; the thin substance of which they consist, not requiring much marrow.

They are joined above the *frontal bone*, by the middle of the *transverse suture*;—behind, to the *maxillary bones*, by the *lateral nasal fures*;—below, to the cartilages of the nose;—before, to one another, by the *anterior nasal suture*;—internally, to the *septum narium*.

These bones serve to cover and defend the root of the nose.

In an infant the *nasal bones* are proportionally shorter, and less thick at their upper part, than in an adult, but are otherwise compleat.

OSSA UNGUIS, or *LACRYMALIA*, are so named, because their figure and magnitude are something near to those of a nail of one's finger, and because the tears pass upon them into the nose.

Their external surface is composed of two smooth concavities and a middle ridge.—The depression behind forms a small share of the orbit for the eye-ball to move on, and the one before is a deep perpendicular canal, or *fossa*, larger above than below, containing part of the lacrymal *sac* and *duct*. This is the part that ought to be pierced in the great operation for the *fistula lacrymalis*.—This *fossa* of the bone is *cribriform*, or has a great number of small holes through it, that the filaments from the membrane which lines it, insinuating themselves into these holes, might prevent a separation of the membrane, and secure the bone in its natural situation.—The ridge between these two cavities of the *os unguis*, is the proper boundary of the orbit at its internal *canthus*; and beyond which surgeons should not proceed backwards in performing operations here.—The internal or posterior surface of this bone consists of a furrow in the middle of two convexities.

The substance of the *os unguis* is as thin as paper, and very brittle; which is the reason that these bones are

are often wanting in skeletons, and need little force to pierce them in living subjects.

Each of these bones is joined, above, to the *frontal* bone, by part of the *transverse* suture;—behind, to the *os planum* of the *ethmoid* bone, by the same suture;—before, and below, to the *maxillary* bone, by the *lacrymal* suture;—internally, the *osseum unguis* covers some of the *sinus ethmoidales*; nay, are really continuous with the bony *lamelle* which make up the sides of these cells; so that they are as much part of the *ethmoid* bone as the *osseum planum*.

These unguiform bones compose the anterior internal parts of the orbits, lodge a share of the lacrymal sac and duct, and cover the *ethmoid* cells.—Their situation and tender substance make a rash operator in danger of destroying a considerable share of the organ of smelling, when he is performing the operation of the *fistula lacrymalis*; but when these bones are hurt, they cast off without much difficulty, and consequently the wound is soon cured, unless the patient labours under a general *cacoethes*, or there is a predisposition in the bones to *caries*; in which case, a large train of bad symptoms follow, or, at best, the cure proves tedious.

These bones are fully formed in a new-born child.

OSSA MALARUM (c) was the name given by *Celsus*, as was already remarked, to all the upper jaw; but is now appropriated to the prominent square bones which form the cheek on each side.—Before, their surface is convex and smooth; backward, it is unequal and concave, for lodging part of the *crotaphytic* muscles.

The four angles of each of these bones have been reckoned processes by some.—The one at the external *canthus* of the orbit, called the *superior orbital process*, is the longest and thickest.—The second terminates near the middle of the lower edge of the orbit in a sharp point, and is named the *inferior orbital process*.—The third, placed near the lower part of the cheek, and

(c) *Jugalia vel zygomatica, hypopia, subocularia.*

and thence called *maxillary*, is the shortest, and nearest to a right angle.—The fourth, which is called *zygomatic*, because it is extended backwards to the *zygoma* of the temporal bone, ends in a point, and has one side straight, and the other sloping.—Between the two orbital angles there is a concave arch, which makes about a third of the external circumference of the orbit, from which a fifth process is extended backwards within the orbit, to form near one third of that cavity; and hence it may be called the *internal orbital process*.—From the lower edge of each of the *osseum malarum*, which is between the maxillary and zygomatic processes, the *masseter* muscle takes its origin; and from the exterior part of the zygomatic process, the *musculus distortor oris* rises; in both which places the surface of the bone is rough.

On the external surface of each cheek-bone, one or more small holes are commonly found, for the transmission of small nerves or blood-vessels from, and sometimes into the orbit.—On the internal surface are the holes for the passage of the nutricious vessels of these bones.—A notch on the outside of the *internal orbital process* of each of these bones, assists to form the great slit common to this bone and to the sphenoid, maxillary, and palate bones.

The substance of these bones is, in proportion to their bulk, thick, hard, and solid, with some *cancelli*.

Each of the *osseum malarum* is joined, by its superior and internal orbital processes, to the *os frontis*, and to the orbital process of the *sphenoid* bone, by the *transverse suture*.—By the edge between the internal and inferior orbital processes, to the *maxillary* bone, by the *internal orbital suture*.—By the side between the *maxillary* and inferior orbital process, again to the *maxillary* bone, by the *external orbital suture*.—By the zygomatic process, to the *os temporum*, by the *zygomatic suture*.

The cheek-bones are entire, and fully ossified in all their parts in infants.

OSSA

OSSA MAXILLARIA SUPERIORA, are the largest bones, and constitute the far greater part of the upper jaw, which has appropriated the name of *maxillaria* to them. The figure of one of them, or of the two when joined, is so irregular, that words can scarce give an idea of it.

The processes of each *os maxillare* may be reckoned seven.—The first is the long nasal one at its upper and fore-part, which is broad below, and turns smaller, as it rises upwards, to make the side of the nose.—At the root of this, a transverse ridge may be observed within the nostrils, which supports the fore-part of the upper edge of the *os spongiosum inferius*.—The second is produced backwards and outwards, from the root of the nasal process, to form the lower side of the orbit, and therefore may be called *orbitar*.—The edge of this *orbitar* process, and the ridge of the nasal one, which is continued from it, make a considerable portion of the external circumference of the orbit.—From the proper *orbitar* process, a very rough triangular surface is extended downwards and outwards, to be connected to the cheek-bone; and therefore may be called the *malar* process, from the lowest protuberant part of which some share of the *masseter* muscle takes its rise.—Behind the *orbitar* process, a large tuberosity or bulge of the bone appears, which is esteemed the fourth process.—On the internal part of this we often meet with a ridge, almost of the same height with that in the nasal process, which runs transversely, and is covered by a similar ridge of the *palate* bone, on which the back-part of the upper edge of the *os spongiosum inferius* rests.—The convex back-part of this tuberosity is rough for the origin of part of the external *pterygoid* muscle (*a*), and more internally is scabrous, where the *palate* and *sphenoid* bones are joined to it.—That spongy protuberance (*b*) at the lower circumference of this bone, where the sockets for the teeth

I

are

(*a*) Albin. de ossib. § 79.

(*b*) Φαρνη.

are formed, is reckoned the *fifth*.—The *sixth* is the horizontal plate, which forms the greater part of the base of the nostrils, and roof of the mouth; its upper surface, which belongs to the nostrils, is very smooth, but the other below is arched and rough, for the stronger adhesion of the membrane of the mouth, which is stretched upon it, and in chewing, speaking, &c. might otherwise be liable to be separated.—The *seventh* rises like a spine from the inner edge of the last, and forms a small part of the partition of the nostrils.

The depressions in each *maxillary* bone are, 1. A sinuosity behind the orbital process, made by the *temporal* muscle. 2. A pit immediately before the same process, where the origin of the *musculus elevator labiorum communis*, and *elevator labii superioris*, with a branch of the fifth pair of nerves, are lodged securely. 3. The hollow arch of the palate. 4. The semicircular great notch, or entry to the lower part of the nostrils, betwixt the root of the nasal process and spine of the palate-plate.—Below this, the fore-part of the bone is flattened, or sometimes hollowed by the *musculus depressor labii superioris*. 5. Sockets for the teeth (*c*): The number of these sockets is uncertain; for the same number of teeth is not in all people, and the four backmost teeth of each side of each jaw vary greatly in their number of roots; and when the teeth of a living person fall out, or are taken away, the sockets fill up with an osseous net-work, which becomes solid afterwards. 6. The *lacrymal fossa* in the *nasal process*, which assists the *os unguis* to form a passage for the *lacrymal duct*. This part of the bone forming this *fossa*, is so firm and strong, that a surgeon scarce can perforate it with the ordinary instruments for the *fistula lacrymalis*, and therefore ought to avoid it in doing this operation.—Immediately on the outside of this, there is a small depression, from which the inferior or lesser oblique muscle of the eye has its origin.

(c) Βοδρία, ὀλυμποῖοι, alveoli, fossulæ, mortariola, fræna, locelli, cævæ, præfepiola, loculamenta.

origin (*d*). 7. The canal on the upper part of the great tuberosity within the orbit, which is almost a complete hole; in this a branch of the superior maxillary nerve passes.—Besides these, the superior surface of the great bulge is concave, to receive the under part of the eye.—Immediately above the transverse ridge in the nasal process, a small hollow is formed by the *os spongiosum*.—In some subjects, the nasal process has a small round pit above the lacrymal duct, where the little tendon or ligament of the orbicular muscle of the eye-lids is inserted. It is this tendon, and not the tendon of the larger oblique muscle of the eye, which there is some hazard of cutting in the operation of the *fistula lacrymalis*.

The holes of this bone are, two proper and two common, which are always to be found; besides several others, whose magnitude, number, &c. are uncertain.—The first of the proper is the *external orbitar*, immediately below the orbit, by which the infra-orbitar branch of the second branch of the fifth pair of nerves, and a small artery, come out, after having passed in the canal, at the bottom of the orbit, described *numb. 7.* of the depressions.—This hole is often double, and that when the nerve has happened to split before it has escaped from the bone.—The second is the *foramen incisivum*, just behind the fore-teeth, which, at its under part, is one irregular hole common to both the *maxillary* bones when they are joined; but, as it ascends, soon divides into two, three, or sometimes more holes: some of which open into each nostril. Through them small arteries and veins, and a twig of the second branch of the fifth pair of nerves pass, and make a communication between, or join the lining coats of the nose and mouth. In some subjects *Steno's* duct may be traced some way on the side of these passages next to the nose, and small orifices may be observed opening into the mouth.

The first common hole is that which appears at the inner side of the back-part of the *tuberosity* and of the sockets of the teeth, and is formed by a *osseum* in this bone, and a corresponding one in the *os palati*: through it a nerve, which is a branch of the second branch of the fifth pair, runs to the palate.—The other common hole is the great slit in the outside of the orbit described already, as the second common hole of the sphenoid bone.

On the nasal process often holes may be observed for the passage of vessels to the substance of the bones; and, at the back-part of each tuberosity, several *foramina* are placed, for the transmission of nerves to the cavity within: but these are uncertain.

All the body of the *maxillary* bone is hollow, and leaves a large *sinus* akin to the *frontal* and *sphenoid*, which is commonly, but unjustly called *antrum Highmoreanum* (*e*). When the *os maxillare* is single, or separated from all the other bones of a skeleton, its *antrum* appears to have a large aperture into the nostrils; but, in a recent subject, it is so covered at its back-part, by the *palate* bone; in the middle, by the *os spongiosum inferius*; before, by a strong membrane, that one, or sometimes two holes, scarce larger than a crow-quill, are only left at the upper part; which, after a short winding progress, open into the nostrils between the two *osseum spongiosum*.—At the bottom of this cavity, we may often observe some protuberances, in which the small points of the roots of the teeth are contained (*f*).—This cavern and the sockets of the teeth are often divided by the interposition only of a very thin bony plate, which is liable to be eroded by acrid matter collected in the *antrum*, or to be broke in drawing a tooth (*g*). The symptoms of a collection of matter here, naturally led us to the practice of pulling out the teeth, and piercing through this plate into the *antrum*, to procure an evacuation

(*e*) *Genz.*

(*f*) *Highmore Disquis. anat.* lib. 3. par. 2. cap. I.
ibid.

vacuation of the collected matter; by which considerable service is frequently done (*b*).

The *maxillary sinuses* have the same uses as the *frontal* and *sphenoidal*; and the situation of the *sinuses* is such, that the liquor drilling from them, from the cells of the ethmoid and palate bones, and from the lacrymal ducts, may always moisten all the parts of the membrane of the *nares* in the different situations which the head is in.

Though the membranes which line the *frontal*, *sphenoidal*, and *maxillary sinuses*, are continuations of the one which covers the bones within the nose; yet they are much thinner than it is, and have so much smaller vessels, that the injection which makes the membrane of the nose red all over, fills only some few vessels of the *maxillary sinuses*, and scarce is observed in the *frontal* and *sphenoidal*. Are not the larger vessels intended for a more plentiful secretion of a viscid liquor to defend the membrane from the effects of the *perflatus*, which is constantly through the nose? Are not the membranes which have the smallest vessels, *ceteris paribus*, the most sensible? Are not many phenomena of smelling, inflammations of these parts, *megrism*, *polypi*, &c. depending on this structure of these membranes?

The substance of the *os maxillaria* is compact and firm, except at the inferior processes, in which the teeth are lodged, where it is very spongy.

The *maxillary bones* are joined above by the upper ends of their nasal processes to the *os frontis*, by the *transverse suture*;—at the sides of these processes, to the *os unguis*, by the *lacrymal sutures*;—to the *nasal bones*, by the *lateral nasal sutures*;—by their orbital processes, to the *cheek bones*, by the *external orbital sutures*;—by the internal sides of the internal orbital processes, to the *os plana*, by part of the *ethmoidal suture*;—by the back-part of the tuberosities, to the *palate bones*, by the *sutura palato-maxillares*;—by the

(*b*) Cowper in Drake's *anthropol.* book 3. chap. 10.—*Medical Essays and observ.* vol. 5. art. 30.

posterior edges of their palatine *lamelle*, to the *osseum palati*, by the *transverse* palate suture;—by their nasal *spines* to the *vomer*, by the *spinous* suture;—by their sockets, to the teeth, by *gomphosis*;—by the internal edge of the palate-plate, to one another, by the *longitudinal* palate suture; on the upper and fore-part of which a furrow is left for receiving the cartilage which forms the partition of the nostrils;—between the fore-part of the nostrils and mouth, to each other, by the *myofacial* suture;—sometimes they are connected to the *osseum spongiosa inferiora*, by a plain concretion or union of substance.

These bones form the greater part of the nose and of the roof of the mouth, and a considerable share of the orbit. They contain sixteen teeth, give rise to muscles, transmission to nerves, &c. as mentioned in the description of their several parts.

In each of the *maxillary* bones of a new-born child, the external orbital process is hollow, with remarkable holes in it;—there are five sockets for the teeth, of which the two posterior are very large, and, when divided by a second cross partition, make the number of sockets six (*i*).—The palate-plate is cribiform about the middle.—The great tuberosity is not formed;—instead of the *antrum*, there is only an oblong depression at the side of the nostrils.

OSSA PALATI are commonly described as two small square bones, at the back-part of the palate or roof of the mouth, though they are of much greater extent, being continued up the back-part of the nostrils to the orbit (*k*). Each palate-bone may therefore be divided into four parts, the palate square bone, the pterygoid process, nasal *lamella*, and orbital process.

The

(*i*) Albin. Osteogen. tab. 5. fig. 45.—Ungebav. de dentit. secund. jun. § 1.

(*k*) Eustach. tab. 47. fig. 1, 3, 6, 7, 8.—Vidus Vidius de Anat. lib. 2. cap. 2. explicat. tab. 6. fig. 19.—Winflow Memoires de l'acad. des sciences, 1720.

The square-bone is unequally concave, for enlarging both the mouth and cavity of the nose. The upper part of its internal edge rises in a spine, after the same manner as the palate-plate of the *maxillary* bone does, to be joined with the *vomer*.—Its anterior edge is unequally ragged, for its firmer connection with the palate process of the *os maxillare*.—The internal edge is thicker than the rest, and of an equal surface, for its conjunction with its fellow of the other side.—Behind, this bone is somewhat in form of a crescent, and thick, for the firm connection of the *velum pendulum palati*; the internal point being produced backwards, to afford origin to the *palato-staphylinus* or *azygos* muscle.—This square bone is well distinguished from the *pterygoid* process by a perpendicular *fossa*, which, applied to such another in the *maxillary* bone, forms a passage for the palatine branch of the fifth pair of nerves; and by another small hole behind this, through which a twig of the same nerve passes.

The *pterygoid* process is somewhat triangular, having a broad base, and ending smaller above. The back-part of this process has three *fossa* formed in it; the two lateral receive the ends of the two plates of the *sphenoid* bone, that are commonly compared to a bat's wing; the middle *fossa* makes up a part of what is commonly called the *fossa pterygoidea*; the fore-side of this palatine *pterygoid* process is an irregular concave, where it receives the back-part of the great *tuberosity* of the *maxillary* bone.—Frequently several small holes may be observed in this triangular process, particularly one near the middle of its base, which a little above communicates with the common and proper holes of this bone already taken notice of.

The *nasal lamella* of this bone is extremely thin and brittle, and rises upwards from the upper side of the external edge of the square bone, and from the narrow extremity of the *pterygoid* process; where it is so weak, and, at the same time, so firmly fixed to

the

the *maxillary* bone, as to be very liable to be broken in separating the bones.—From the part where the plate rises, it runs up broad on the inside of the *tuberosity* of the *maxillary* bone, to form a considerable share of the sides of the *maxillary sinus*, and to close up the space between the *sphenoid* and the great bulge of the *maxillary* bone, where there would otherwise be a large slit opening into the nostrils (1). From the middle internal side of this thin plate, a cross-ridge placed on such another of the *maxillary* bone is extended; on it, the back-part of the *os spongiosum inferius* rests.—Along the outside of this plate, the perpendicular *fossa* made by the *palate nerve* is observable.

At the upper part of this nasal plate, the palate-bone divides into two processes, which I already named *orbitar*;—between which and the body of the *sphenoid* bone, that hole is formed, which I mentioned as the last of the holes common to the *sphenoid* bone.—Sometimes this hole is wholly formed in the *os palati*, by a cross plate going from the one *orbitar* process to the other. A nerve, artery, and vein belonging to the nostrils pass here.—The anterior of the two *orbitar* processes is the largest, and has its fore-part contiguous to the back-part of the *maxillary sinus*, and its upper surface appears in the bottom of the orbit, behind the back-part of the *os maxillare* and *planum*.—It has cells behind, resembling those of the *ethmoid* bone, to which it is contiguous; it is placed on the aperture of the *sinus sphenoidalis*, so as to leave only a round hole at its upper fore-part.—The other part of the *orbitar* process is extended along the internal side of the upper back-part of the *maxillary tuberosity*, to the base of the *sphenoid* bone, between the root of the *processus azygos* and the *pterygoid* process.

The palate square part of this palate-bone, and its *pterygoid* process, are firm and strong, with some *cancelli*.

(1) Albin. de offic. § 88.

cancelli; but the nasal plate and orbital processes are very thin and brittle.

The palate-bones are joined to the *maxillary*, by the fore-edge of the palate square-bone, by the *transverse palate suture*:—By their thin nasal plates, and part of their orbital processes, to the same bones, by the *palato-maxillares sutures*:—By their *pterygoid processes*, and back-part of the *nasal plates*, to the *ala vespertilionum*, by the *sphenoid suture*:—By the transverse ridges of the nasal plates, to the *osse spongiosa inferiora*, by contact; hence frequently there is an intimate union of the substance of these bones in old skulls:—By the orbital processes, to the *osse plana* and *cellulae ethmoideæ*, by the *ethmoid suture*:—To the body of the *sphenoid bone* by the *sphenoid suture*:—By the internal edge of the square bones, to each other, by the *longitudinal palate suture*; and by their nasal spines, to the *vomer*, by the *spinous suture*.

The palate-bones form part of the palate, nostrils, orbits, and *fossa pterygoideæ*, and they cover part of the *sinus maxillares*, *sphenoidales*, and *ethmoidei*.

These bones are very complete in a new-born infant, the nasal plates being then thicker and stronger than in adults; but the orbital processes have not the cells which appear in the bones of adults.

When we are acquainted with the history of these bones, the reason is evident, why the eyes are so much affected in ulcers of the palate, as to be often attended with blindness, which frequently happens in an ill-managed *lues venerea*; or why, on the other hand, the palate suffers from an *agylops* (*m*).

OSSA TURBINATA, or *spongiosa inferiora*, resemble the superior *osse spongiosa* in shape and substance, but have their anterior and upper edges contiguous to the transverse ridges of the nasal processes of the *maxillary* and *palate bones*.—From their upper straight edge, two small processes stand out: the posterior, which is the broadest, descends to cover some of the *antrum Highmorianum*; the anterior rises up to

(*m*) Hoffmann in *Ephemerid. German. cent.* I. and 2. observ. 135.

join the *os unguis*, and to make part of the *lacrymal duct*.

Below the spongy bones already mentioned, there are sometimes two others, one in each nostril, which seem to be a production of the sides of the maxillary *sinus* turned downwards (*n*). When this third sort of spongy bones is found, the middle one of the three in each nostril is the largest, and the lowest is the smallest.—Besides all these, there are often several other small bones standing out into the nostrils, that, from their shape, might also deserve the name of *turbanata*, but are uncertain in their bulk, situation, and number (*o*).

The names of these bones sufficiently declare their spongy substance, which has no firm external plate covering it.

They are joined to the *os maxillaria palati*, and *unguis* in old subjects, by a firm union of substance: And as this happens also frequently in people of no great age, some (*p*) are of opinion, that they should be esteemed part of the palate-bones; others (*q*) think, that since their upper edge is continued by a plate to a part of the *os ethmoides*, they ought to be esteemed to be a part of this bone.

Their use is, to straiten the nostrils, to afford a large surface for extending the organ of smelling, to cover part of the *antra maxillaria*, and to assist in forming the under part of the lacrymal ducts, the orifices of which into the nose are concealed by these bones.

The *os turbinata* are nearly complete in a new-born infant.

VOMER, or bone resembling a plough-share, is the thirteenth of the upper jaw, without a fellow, forming the lower and back parts of the partition of the nose (*r*).

The

(*n*) Cowper in Drake's Anthropolog. book 3. chap. 10.

(*o*) Santorin. Observat. anatomic. cap. 5. § 9.

(*p*) Id. ibid. cap. 5. § 7.

(*q*) Hunauld Memoires de l'acad. des sciences, 1730.

(*r*) Columb. de re Anat. lib. 1. cap. 8.—Fallop. Observat. anatom.

The figure of this bone is an irregular rhomboid.—Its sides are flat and smooth.—Its posterior edge appears in an oblique direction at the back-part of the nostrils.—The upper one is firmly united to the base of the *sphenoid* bone, and to the nasal plate of the *ethmoid*; and, when it can be got separated, is hollow, for receiving the *processus azygos* of the *sphenoid*.—The anterior edge has a long furrow in it, where the middle cartilage of the nose enters.—The lower edge is firmly united to the nasal spines of the maxillary and palate bones.—These edges of this bone are much thicker than its middle, which is as thin as the finest paper; by which, and the firm union or connection this bone has above and below, it can very seldom be separated entire in adults: But, in a child, it is much more easily separated entire, and its structure is more distinctly seen: Wherefore I shall examine all its parts of such a subject.

Its situation is not always perpendicular, but often inclined and bended to one side, as well as the nasal plate of the *ethmoid* bone.

The *vomer* is convex at its upper part, and then is straight, as it is extended downwards and forwards, where it is composed of two plates; the edges of which have a great number of small processes, disposed somewhat like the teeth of a saw, but more irregularly, and several of them are reflected back. Between these plates a deep *fossa* is left, which, so far as the top of the curvature, is wide, and has strong sides, for receiving the *processus azygos* of the *sphenoid* bone. Beyond the arch forwards, the *fossa* is narrower and shallower gradually to the point of the bone, receiving for some way the nasal *lamella ethmoidea*, which, after the ossification is complete, is so closely united to the *vomer* by the little processes piercing into its substance, as to prevent any separation; on which account, it has been esteemed by some (s) a part of the *ethmoid* bone. The middle cartilage of the nose fills up what remains of the *fossa*

(s) Lieutaud. *Essais anatomiques* 1. sect. l'os ethmoide.

foſſa at its fore-part.—The posterior edge of the *vomer*, which appears above the back-part of the palate bones, is broader above; but as it descends forwards, becomes thinner, though it is still solid and firm.—The lower edge of this bone, which rests on the nasal spine of the *palate* and *maxillary* bones, has a little furrow on each side of a small middle ridge, answering to the spines of the bones of different sides, and the interstices between them. This edge, and the upper one, meet in the pointed fore-end of this bone.

The body of the *vomer* has a smooth surface, and solid, but thin substance; and towards its sides, where it is thickest, some *cancelli* may be observed, when the bone is broken.

It is joined above to the *sphenoid* and *ethmoid* bones, and to the middle cartilage of the nose by *synchondrosis*;—below, to the *maxillary* and *palate* bones, by the *spinous future*.

The *vomer* divides the nostrils, enlarges the organ of smelling, by allowing place for expanding the membrane of the nose on its sides, and sustains the palate-plates of the *maxillary* and *palate* bones, which otherwise might be in hazard of being pressed into the nostrils; while the *vomer* is secured from shuffling to one side or other by the double *synchondrosis*, by which it is joined to the bones above and below.

These, then, are all the bones which compose the upper jaw, except the teeth, which are so much akin to those of the lower jaw, that I choose to make one description serve for both, in which the differences observable in them shall be remarked, after the second part of the face, the lower jaw, is examined; because the structure of the teeth cannot be well understood, until the case in which they are set is explained.

MAXILLA INFERIOR (*t*), the lower jaw, consists

(*t*) *Tvros, σταγνη, mandibula, facies.*

fists only of one moveable bone, and sixteen teeth incased into it.

This bone, which is somewhat of the figure of the Greek letter ν , is situated at the lower part of the face, so as its convex middle part is forwards, and its legs are stretched back. It is commonly divided into the chin, sides, and processes.—The *chin* is the middle fore-part, the extent of which to each side is marked on the external surface by the holes observable there, and internally by the beginning of an oblique ridge.—Beyond these the *sides* appear, and are continued till the bone, by bending upwards, begins to form the processes.

On the fore-part of the *chin*, a transverse ridge appears in the middle, on each side of which the *musculi quadrati*, or *depressores labii inferioris*, and the *levatores labii inferioris*, depress the bone: And below these prints, a small rising may be observed, where the *depressores* commence.—On the back-part of the chin, sometimes three, always two, small protuberances appear in the middle. To the uppermost, when it is seen, the *frænum* of the tongue is connected. From the middle one, the *musculi genio-glossi* rise; and from the lowest, the *genio-hyoidei* have their origin. Below the last, we see two rough sinuosities formed by the *digastric* muscles.

At the lower and fore-part of the external surface of each side of the lower jaw, a small eminence may be observed, where the *depressor labiorum communis* rises. Near the upper edge of the side, a ridge runs length-ways, to which the under-part of the *musculus buccinator* is connected.—Internally, towards the upper edge of each side, another ridge appears, from which the *mylo-hyoidei* have their origin, and to which the internal membrane of the gums adheres.

In the upper edge of both chin and sides are a great many deep pits or sockets, for receiving the roots of the teeth. The number and magnitude of these sockets are various, because of the different number, as well of the teeth themselves, as of their

roots, in different people. These sockets in this lower jaw, as well as in the upper one, are less deep as old age comes on; when freed from the teeth by any means, they are some time after filled up with an osseous net-work, which at last becomes entirely solid, and as smooth as any other part of the bone; so that in a great many old jaws, one cannot observe a vestige of the sockets: But then the jaw becomes less, and much narrower (*u*).—Hence we may know why the chin and nose of edentulous people are much nearer than before the teeth were lost; while their lips either fall in towards the mouth, or stand prominent forwards.—When new teeth are protruded, new sockets are formed (*x*).—The lower edge of the chin and sides is smooth and equal, and is commonly called the *base* of the lower jaw.—The ends of the base, where the jaw turns upwards, are called its *angles*; the external surface of each of which has several inequalities upon it, where the *masticator* muscle is inserted; as the internal surface also has, where the *pterygoideus internus* is inserted, and a ligament extended from the *styloid* process of the temporal bone is fixed.

The processes are two on each side.—The anterior sharp thin *coronoid* ones have the *crotaphytes* muscles inserted into them.—The posterior processes or *condyles* (*y*) terminate in an oblong smooth head, supported by a *cervix*. The heads, whose greatest length is transverse, and whose convexity is turned forwards, are tipped with a cartilage, as the articulated parts of all other moved bones are.—The fore-part of the root and neck of these *condyloid* processes are a little hollow and rough, where the external *pterygoid* muscles are inserted.

The holes of the lower jaw are two on each side; one at the root of the processes internally, where a large branch of the third branch of the fifth pair of nerves

(*u*) Vesal. Anat. lib. I. cap. 10.

(*x*) Fallop. Observ. Anat.

(*y*) Articulatorii.

nerves enters with an artery, and a vein returns. A small sharp process frequently juts out backwards from the edge at the fore-part of this hole, to which a ligament extended from the temporal bone is fixed (*y*), which saves the nerve and vessels from being too much pressed by the *pterygoid* muscles.—From the lower side of this hole, either a small superficial canal or a furrow descends, where a branch of the nerve is lodged, in its way to the *mylo-hyoideus* muscle and sublingual gland (*z*). The other hole is external, at the confines of the chin, where branches of the nerve and vessels come out.—The canal betwixt these two holes is formed in the middle of the substance of the bone, and is pierced by a great number of small holes, by which the nerves and blood-vessels of the *cancelli* and teeth pass.—This canal is continued a little further than the external hole at the chin.—On account of the vessels and nerves in the lower jaw, fractures of it may be attended with dangerous symptoms.

The surface of the lower jaw is hard and firm, except at the spongy sockets, where however it is stronger than the upper jaw.—Its internal substance is cellular, without any solid partition between the *cancelli* in its middle.—At the base, especially of the chin, where this bone is most exposed to injuries, the solid sides of it are thick, compact, and hard.

The lower jaw generally receives the roots of sixteen teeth into its sockets, by *gomphosis*; and its *condyloid* processes, covered with cartilage, are articulated with the *temporal* bones, in a manner that is not commonly described right: For, as was already mentioned in the description of the *temporal* bones, not only the fore-part of the cavity between the *zygomatic*, *auditory*, and *vaginal* processes, but also the adjoining tubercle at the root of the *zygomatic* process of each *os temporum* is covered with a smooth cartilage, for this articulation. Here also an intermediate moveable cartilage is placed,

K 2

(*y*) Weitbrecht Syndesmolog. fig. 32. 1.

(*z*) Palfyn. Anat. chirur. traité 5. chap. 6.

ced, which being thin in the middle, and thick at the edges, is concave on both sides; and is connected so firmly by ligaments to each *condyle*, as to follow the motions of the *condyle*; and so loosely to the *temporal* bone, as readily to change its situation from the cavity to the tubercle, and to return again; while the common ligament of the articulation affords space enough for such a change of place backwards and forwards; but, like other ligaments of the joints by *ginglimus*, is strong and short at the sides, to confine the lateral motions.

When therefore the teeth of both jaws coincide, the *condyles* are lodged securely in the temporal cavities, but their motions to either side must be confined both by the firmness of the ligaments, and the rising brims which are on each side of the cavities.— When the jaw is brought directly forwards, the *condyle* and intermediate cartilages descend and advance forwards upon the tubercles.—In this situation the lateral motions are a little more free than in the former one, from the want of rising brims to stop the *condyles*.—When the fore-teeth of the lower jaw are moved forwards, and to a side, the *condyle* of the opposite side is either advanced from the cavity to the tubercle, while the *condyle* of the same side remains in the cavity; or if both *condyles* are on the tubercles, when the jaw is moved obliquely to a side, the *condyle* of the side to which the motion is made, slides back from the tubercle to the cavity.—When the mouth is opened by the descent of the lower jaw, the fore-part of it, where the *depressing* muscles are fixed, is drawn backwards, as well as downwards, while resistance is made to the angles moving backwards by the *masseter* and *internal pterygoid* muscles, and, at the same time, the *external pterygoid* draw the *condyles* and their moveable cartilages forwards; and therefore, when the mouth is opened, the *condyles* are carried forwards upon the tubercles, and the axis of motion of the bone is a little above its angles. But in this situation there is less resistance than in any

any other, to the condyles luxating forwards; a disease which seldom happens, except when people are gaping too wide; and therefore the common practice of nurses, who support the jaw of infants when they are yawning, is reasonable.—In chewing there is a succession of the motions above described (a).

Here a general remark may be made, That wherever moveable cartilages are found in joints, either the articulated bones are of such a figure, or so joined and fixed by their ligaments, that little motion would be allowed without such cartilages; or else some motions are necessary to the right use of the member, which the form of the articulation would not otherwise admit of. This will more fully appear after the other joints with such cartilages are described.

In a child born to the full time, the lower jaw is composed of two bones, connected by a thin cartilage in the middle of the chin, which gradually ossifies, and the two bones intimately unite.—In each of these bones there are five or six sockets for teeth, as in the upper jaw.

After I have thus described the incasement of the teeth, the insertion of so many muscles of the tongue, and of the *os hyoides*, the connection of the membrane of the tongue to the maxillary bone, and the motions of this bone; it is easy to see, that the lower jaw must be a principal instrument in manducation, deglutition, and speech.

The *TEETH* are the hard white bodies placed in the sockets of both jaws. Their number is generally sixteen above, and as many below; though some people have more, others have fewer.

The broad thick part of each tooth which appears without the socket, is the *base* or *body* (b).—The smaller processes sunk into the *maxilla*, are the *roots*

K 3

or

(a) For a more full account of this articulation, *vide* Edinburgh Medical Essays and Observ. vol. I. art. II. and vol. 3. art. 13.—*Memoires de l'acad. des Sciences*, 1744.

(b) *Corona*.

or *fangs*, which become gradually smaller towards the end farthest from the base, or are nearly conical, by which the surface of their sides divides the pressure made on the bases, to prevent the soft parts, which are at the small points of the sockets, to be hurt by such pressure.—At the place where the base ends, and the roots begin, there is generally a small circular depression, which some call the *neck* or *collar*.

Without the gums, the teeth are covered with no membrane, and they are said to have no proper *periosteum* within the sockets; but that is supplied by the reflected membrane of the gums; which, after a good injection, may be evidently seen in a young subject, with the vessels from it penetrating into the substance of the teeth; and it may be discovered in any tooth recently pulled, by macerating it in water (c). The adhesion of this membrane to these roots is strengthened by the small furrows observable on them.

Each tooth is composed of its *cortex*, or *enamel*, and an internal bony substance. The *cortex* has no cavity or place for marrow; and is so solid and hard, that saws or files can with difficulty make impression on it. It is thickest upon the base, and gradually, as the roots turn smaller, becomes thinner, but not proportionally to the difference of the size of the base and roots.—The fibres of this enamel are all perpendicular to the internal substance, and are straight on the base, but at the sides are arched with a convex part towards the roots (d); which makes the teeth resist the compression of any hard body between the jaws, with less danger of breaking these fibres, than if they had been situated transversely. The spongy sockets in which the teeth are placed, likewise serve better to prevent such an injury, than a more solid base would have done.—Notwithstanding the great hardness of this *cortex*, it is wasted by manducation.

Hence

(c) Cowper Anatom. explicat. tab. 92. fig. 7. lit. E.

(d) Haver's Osteolog. nov. disc. I.

Hence the sharp edges of some teeth are blunted, and made broad, while the rough surfaces of others are made smooth and flat, as people advance in life.

The bony part of the teeth has its fibres running straight, according to the length of the teeth. When it is exposed to the air, by the breaking or falling off of the hard *cortex*, it soon corrupts. And thence carious teeth are often all hollow within, when a very small hole appears only externally.

The teeth have canals formed in their middle, wherein their nerves and blood-vessels are lodged; which they certainly need, being constantly wasted by the attrition they are subjected to in manducation, and for their further growth, not only after they first appear, but even in adults; as is evident when a tooth is taken out: For then the opposite one becomes longer, and those on each side of the empty socket turn broader; so that when the jaws are brought together, it is scarce observable where the tooth is wanting (a).

The vessels are easily traced so long as they are in the large canal, but can scarce be observed in their distribution from that to the substance of the teeth of adults. Ruyfch (b) however affirms, that after injection, he could trace the arteries into the hardest part of the teeth: And Leewenhoek (c) suspected the fibres of the *cortex* to be vessels. In children I have frequently injected the vessels of the teeth as far as their base: And in such as are not intirely ossified, one can with a lucky injection fill so many vessels, as to make both the outside and inside of the cortical part appear perfectly red.—This plentiful supply of vessels must expose the teeth to the same disorders that attack other vascular parts; and such teeth as have the greatest number of vessels, must have the most numerous chances of being seized with these diseases.

Every root of each tooth has such a distinct canal, with

(a) *Ingraf. de tumor.* cap. I. p. 24. 25. 26.

(b) *Thesaur.* 10. num. 27.

(c) *Arcan. natur. continuat. epist.* p. 3.

with vessels and nerves in it. These canals in the teeth with more than one root, come nearer each other, as they approach the base of the tooth ; and at last are only separated by very thin plates, which being generally incompleat, allow a communication of all the canals ; and frequently one common cavity only appears within the base, in which a pulpy substance composed of nerves and vessels is lodged. The condition therefore of the nerves here, bears a strong analogy to that of the cutaneous nerves which serve for the sensation of touching.

The entry of the canals for these vessels is a small hole placed a little to a side of the extreme point of each root ; sometimes, especially in old people, this hole is entirely closed up, and consequently the nerves and blood-vessels are destroyed (*d*).

The teeth are seen for a considerable time in form of *mucus* contained in a membrane, afterwards a thin cortical plate, and some few osseous layers appear within the membrane, with a large cavity filled with *mucus* in the middle ; and gradually this exterior shell turns thicker, the cavity decreases, the quantity of *mucus* is lessened, and this induration proceeds till all the body is formed ; from which the roots are afterwards produced.

In young subjects, different *stamina* or rudiments of teeth are to be observed. Those next the gums hinder ordinarily the deeper seated ones from making their way out, while these prevent the former from fending out roots, or from entering deep into the bony sockets of the jaws ; by which they come to be less fixed.

Children are seldom born with teeth ; but at two years of age they have twenty ; and their number does not increase till they are about seven years old, when the teeth that first made their way through the gums are thrust out by others that have been formed deeper in the jaw, and some more of the teeth begin to discover themselves farther back in the mouth.

(d) De la Hire Histoire de l'acad. des sciences, 1699.

About fourteen years of age, some more of the first crop are shed, and the number is increased.—This shedding of the teeth is of good use; for if the first had remained, they would have stood at a great distance one from another; because the teeth are too hard in their outer crust, to increase so fast as the jaws do. Whereas both the second layer, and the teeth that come out late, meeting, while they are soft, with a considerable resistance to their growth in length, from those situated upon them, necessarily come out broad, and fit to make that close guard to the mouth (*e*), which they now form.

The teeth are joined to the sockets by *gomphosis*, and the gums contribute to fix them there; as is evident by the teeth falling out when the gums are any way destroyed, or made too spongy; as in the *scurvy* or *salivations*: whence some (*g*) class this articulation with the *sypharosis*.

The uses of the teeth are to masticate our aliment, and to assist us in the pronunciation of several letters.

Though the teeth so far agree in their structure, yet, because of some things wherein they differ, they are generally divided into three classes, *viz.* *incisores*, *canini*, and *molares*.

The *incisores* (*b*) are the four fore-teeth in each jaw, receiving their name from their office of cutting our aliment; for which they are excellently adapted, being each formed into a sharp cutting edge at their *base*, by their fore-side turning inwards there, while they are sloped down and hollowed behind (*i*); so that they have the form of wedges; and therefore, their power of acting must be considerably increased.—Seeing in the action of the *incisores*, a perpendicular compression is only necessary, without any lateral motion, they are not so firmly fixed in their sockets

(*e*) Φραγμός.

(*g*) Drake's Anthropolog. book 4. chap. 3.

(*b*) Γελαστοί, τομικοί, διχαενής, κτενες, τομες, πρωτοβιος, οξεις, risorii, quaterii, primi, primores, anteriores, acuti.

(*i*) Ολμισχος.

as the other teeth are, each having only one short root, but that is broader from before backwards, than to either side, to have the greatest strength where it is exposed to the strongest force applied to it (*k*).

The *incisores* of the upper jaw, especially the two middle ones (*l*), are broader and longer generally than those of the under jaw.

In a new-born infant, the outer shell of the body of these teeth is only hardened.—Afterwards, when the *stamina* of two sets are formed, each has its own socket, those nearest to the edge of the gums being placed more forward, and the others are lodged farther back within the jaw-bones.

Canini (*m*), from the resemblance to dogs' tusks, are one on each side of the *incisores* in each jaw.—The two in the upper jaw are called *eye-teeth*, from the communication of nerves which is said to be betwixt them and the eyes.—The two in the lower jaw are named *angular* or *wike-teeth*, because they support the angles of the mouth.

The *canini* are broader, longer, and stronger, than the *incisores*.—Their bases are formed into a sharp edge, as the *incisores* are; only that the edge rises into a point in the middle.—Each of them has generally but one long root, though sometimes they have two (*n*). The roots are crooked towards the end.—The *canini* of the upper jaw are larger, longer, and with more crooked roots, than those of the under jaw.—The form of their base is fit both for piercing and cutting, and the long crooked root of each makes it secure in the socket.

The *canini* of a child are in much the same condition as the *incisores* are.

The *dentes molares*, or *grinders* (*o*), which have got their name because they grind our food, are generally

(*k*) Lettre sur l'ostéologie, ascribed to Du Verney.

(*l*) *Duales.*

(*m*) Κυνοδοντες, *risorii*, *fractorii*, *collaterales*, *collumellares*.

(*n*) Fauchard, *Chirurgien dentiste*, chap. I.

(*o*) Μυλιται, *γωμφοι*, *μυλοι*, *πλατεις*, *φρασηρες*, *maxillares*, *meñales*, *clavales*, *buccarum*.

ly five in each side of each jaw; in all twenty. Their bases are broader, more scabrous, and with a thinner cortical substance, than the other teeth. They have also more roots, and as these roots generally diverge from each other, the partitions of the sockets between them bear a large share of the great pressure they suffer, and hinder it to act on their points (*p*).

The base of the first grinder has an edge pointed in the middle, on its outside, resembling the *canini*; from which it slopes inwards till it rises again into a point.—It has generally but one root, which sometimes is long and crooked at its point.

The second *dens molaris* has two points on its base, rising near equally on its out and inside.—It has two roots, either separate or run together, but shorter than the root of the first.—These two anterior grinders are much smaller than the three that are placed farther back in the mouth.

The third and fourth are very broad in their bases, with four or five points standing out; and they have three or more roots.

The fifth, called commonly *dens sapientiae* (*q*), from its coming through the gums later than the other grinders, has four points on its base, which is not so large as the base of the third and fourth, and its roots are less numerous.

The *incisores* of the upper jaw, being broader than those of the lower jaw, make the superior grinders to be placed so much farther back than the lower ones, that when they are brought together, by shutting the mouth, the points of the grinders of the one jaw enter into the depressions of the opposite grinders, and they are all equally applied to each other, notwithstanding the inequality of their surface.

The numerous roots of the *dentes molares* prevent their loosening by the lateral pressure they suffer in grinding; and as the sockets in the upper jaw are more

(*p*) Lettre sur l'osteologie.

(*q*) Σωρονίστες, χραύγης, οδιόνος, σένσυς, ιντελεκτος, σερπίνι, ξεταμοντελετες, γενουίνι, μοδερατορες.

more spongy, and the teeth are more liable, by their situation, to fall out (*r*), the grinders there have more numerous and more separated roots than in the lower jaw (*s*). The number however of the roots of the teeth of both jaws is very uncertain; sometimes they are more, sometimes fewer; frequently several roots are joined together; at other times they are all distinct. The disposition of such as are distinct is also various; for in some the roots stand out straight, in others they separate, and in others again they are crooked inwards. When the roots are united, we can still distinguish them, by remarking the number of small holes at their points, which determine the number of roots each tooth ought to be reckoned to have.

At the time of birth only two *dentes molares* in each jaw have begun to ossify, and that at little more than the base; which has several sharp points standing out from it.—The temporaneous grinders are placed more directly upon the internal set than the other two classes are; sometimes there is a piece of the bone of the jaws between the two sets; in other children, the two sets have no bone interposed between them.

From what has been said, the answers to the following queries may be given.

Why are children subject to salivation, fever, convulsion, vomiting, purging, &c. when their teeth are breeding or cutting the gums?

Why in children do the *dentes incisores* first cut the gums, the *canini* next, and *molares* last?

Why do children shed their teeth?

Wherefore have these temporaneous teeth generally no roots, or very small ones?

Why have these first teeth sometimes roots, and that more frequently in teeth pulled by art than in those which are shedded by nature (*a*)?

Why

(*r*) Galen. de ossib. cap. 5.

(*s*) Fauchard. Chirurg. dent. chap. I.

(*a*) Fauchard. Chirurgien dentiste, p. 7.

Why do these roots frequently come outwards through the gums?

Whence come *butter* or *buck* teeth?

How do these teeth sometimes go into the natural row with the others, after pulling a rotten tooth near them?

How have some people got two rows of teeth in one or both jaws (*b*)?

Why do the teeth of old people loosen, and then drop out entire?

Whence arise the new sets of teeth which several old people obtain (*c*)?

Why are not the gums of toothless old people torn by the hard sockets in chewing?

Why are the teeth insensible when slightly filed or rasped?

How come they to be sensible of heat or cold, to be set on edge by acids, or to give an uneasy sensation when gritty or sandy substances are rubbed between them?

Why does a person who has a pained tooth imagine it longer than any other?

What is the reason of some persons dying convulsed, upon rasping or filing down an overgrown tooth (*d*)?

How do the teeth break and moulder away without any pain in some people, and not in others?

What parts are affected in the tooth-ach?

What are the causes of the tooth-ach?

May worms be reckoned among these causes (*e*)?

Why are the *dentes molares* most subject to that disease?

In what different manners ought the several classes of teeth to be extracted when such an operation is necessary?

Whence proceeds the violent obstinate *hemorrhagy* which

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(*b*) Blaf. comment. ad Vessling. Syntagma. cap. I. 3.

(*c*) Hoffman. in Van Horn. microcosm. p. 38.

(*d*) Bartholin. Anat. reformat. lib. 4. cap. 12.

(*e*) Jacob. in Act. Hafn. vol. 5. obs. 107.—Pechlin. Observ. medic. lib. 2. obs. 36.—Bartholin. Hist. medic. cent. 3. hist. 96.

which sometimes attends the drawing of teeth (*c*)?

Why is it more difficult and dangerous to draw the eye-teeth than any other?

What makes it impossible frequently to draw *grinders* without bringing away part of the jaw-bone with them, or breaking the fangs?

Why do teeth soon replaced after being extracted, become again fixed in the sockets (*d*)?

According to the division made of the skeleton, we should now proceed to the description of the trunk of the body. But must first consider a bone, which cannot well be said to belong to either the head or the trunk; nor is it immediately joined to any other, and therefore is very seldom preserved with skeletons. However, it is generally described by authors after the bones of the face: In obedience therefore to the prevailing method, I shall next examine the structure of

The *OS HYOIDES* (*e*), which is situated horizontally between the root of the tongue and the *larynx*. It is properly enough named *hyoides*, from the resemblance it bears to the Greek letter *v*, and may, for a clearer demonstration of its structure, be distinguished into its *body*, *cornua*, and *appendices*.

The body is the middle broad part, convex before, and hollow behind.—The convex fore-part is divided into two, by a ridge, into the middle of which the *mylo-hyoidei*, and into the sides the *stylo-hyoidei*, muscles are inserted.—Above the ridge, the bone is horizontal, but pitted in the middle by the insertion of the two *genio-hyoidei* muscles, and a little hollowed more laterally by the *basio-glossi*.—Below the ridge, it is convex, but a little flattened in the middle by the *sterno-hyoidei*, and pitted more externally by the *coraco-hyoidei*.—

(*c*) Pare, livre 6. chap. 2.—Rolinac. lib. 2. cap. 27. et 30.—Moebill Fundam. medicin. cap. 9.—Ephemerid. German. dec. 1. ann. 3. obs. 319.—Fauch. Chirurg. dentiste, tom. 1. chap. 23. observ. 7.

(*d*) De la Motte Chirurgie, tom. 1. chap. 4. obs. 2.—Fauchard, Chirurgien dentiste, tom. 1. chap. 29.

(*e*) Hypsyloides, Lambdoides, *τεραστην*, *φερυγγιτηρον*, os gutturus, os lingua, os morsus Adami, asperior, os laude, bicorne.

hyoidei.—The concavity behind faces backwards and downwards to receive the *thyroid cartilage*, when the *larynx* and the *os hyoides* are pulled towards each other by the action of the *sterno-hyoidei* and *hyo-thyroidaei* muscles; and to its upper edge, the ligamentous membranes of the *epiglottis*, tongue, and *thyroid cartilage*, are fixed.

The *cornua* of the (i) *os hyoides* are stretched backwards from each side of its body, where often a small furrow points out the former separation; for in young subjects, the body and *cornua* are not one continued substance, as they come afterwards to be in adults.—These *cornua* are not always straight, nor of equal length; their two plain surfaces stand obliquely sloping from above outwards and downwards.—Into the external, the *cerato-glossus* is inserted above, and the *thyro-hyoideus* muscle below; and to the one behind, the ligamentous membrane of the tongue and *larynx* adheres. Each of the *cornua* becomes gradually smaller, as it is extended from the base; but ends in a round tubercle, from which a moveable cartilage stands out, which is connected to the upper process of the *cartilago thyroidea*.

Where the body of the *os hyoides* joins on each side with its *cornua*, a small styloid process, called *appendix (g)*, rises upwards and backwards, into which the *musculi stylo-hyoidei alteri*, and part of the *hyo-glossi* muscles are fixed. From each of them a ligament is sometimes extended to the *styloid* processes of the temporal bones, to keep the *os hyoides* from being drawn too much forwards or downwards. The part of this ligament next to these processes sometimes forms into several cartilages, which afterwards ossify in old people. *Ruysh (h)* says, that he has seen this ossification continued as far up as the *styloid* processes, which were therefore joined to the *os hyoides* by *ankylosis*.

The substance of the *os hyoides* is cellular, but covered with a firm external plate, which is of sufficient

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strength

(i) *Crura, latera inferiora.*(g) *Crura superiora, latera superiora, ossa graniformia.*(h) *Advers. anat. dec. 3. § 9.*

strength to bear the actions of so many muscles as are inserted into it.

It is not articulated with any bone of the body, except by means of the muscles and ligaments mentioned.

The use of the *os hyoides*, is to serve as a solid lever for the muscles to act with, in raising or depressing the tongue and *larynx*, or in enlarging and diminishing the capacity of the *fauces*.

At birth, this bone is in a cartilaginous state; excepting a small point of bone in the middle of its body, and in each of the *cornua*.—The *appendices* frequently remain cartilaginous many years.

O F T H E T R U N K .

TH E TRUNK consists of the *spine*, *pelvis*, and *thorax*.

The *SPINE* (*a*) is the long pile of bones extended from the *condyles* of the *occiput* to the end of the rump. It somewhat resembles two unequal pyramids joined in a common base. It is not, however, straight; for its upper part being drawn backwards by strong muscles, it gradually advances forwards, to support the *œsophagus*, vessels of the head, &c. Then it turns backwards, to make place enough for the heart and lungs. It is next bended forwards, to support the *viscera* of the *abdomen*. It afterwards turns backwards, for the enlargement of the *pelvis*. And lastly, it is reflected forwards, for sustaining the lowest great gut.

The *spine* is commonly divided into *true* and *false vertebræ*; the former constituting the long upper pyramid, which has its base below; while the *false vertebræ* make the shorter lower pyramid, whose base is above.

The

(a) Παχις νωτον ακαθα, ισρα ευριγξ, σωλην, *tergum*, *hominis carina*.

The *TRUE VERTEBRAE* (*b*) are the twenty four upper bones of the *spine*, on which the several motions of the trunk of our bodies are performed; from which use they have justly got their name.

Each of these *vertebrae* is composed of its body and processess.

The body is the thick spongy fore-part, which is convex before, concave backwards, horizontal and plain in most of them above and below.—Numerous small holes, especially on the fore and back part of their surface, give passage to their vessels, and allow the ligaments to enter their substance.—The edges of the body of each *vertebra* are covered, especially at the fore-part, with a ring of bone firmer and more solid than the substance of the body any where else. These rings seem to be joined to the *vertebrae* in the form of *epiphyses*, but are alledged by some (*c*) to be the ligaments ossified. They are of great use in preventing the spongy bodies from being broken in the motions of the trunk.

Between the bodies of each two adjoining *vertebrae*, a substance between the nature of ligament and cartilage is interposed; which seems to consist of concentrical curve fibres, when it is cut horizontally; but when it is divided perpendicularly, the fibres appear oblique and decussating each other (*d*).—The outer part of the intervertebral ligaments is the most solid and hard; and they gradually become softer till they are almost in the form of a glairy liquor in the centre; and therefore these substances were not improperly called *mucous ligaments* by the ancients (*e*). The external fibrous part of each is capable of being greatly extended, and of being compressed into a very small space, while the middle fluid part is incompreffible, or nearly so; and the parts of this ligament

L 3

between

(*b*) Στροφεις, στροφιγγις, spondyli, ossa orbiculata, ossa vertebrata, verticula.

(*c*) Fallop. Observat. anatom.

(*d*) Blancard, Anat. reform. cap. 32.—Weitbrecht, Syndesmolog. sect. 4. § 15.

(*e*) Galen de usu part. lib. 12. cap. 16.

between the circumference and centre approach in their properties to either, in proportion to their more solid or more fluid texture. The middle point is therefore a *fulcrum*, or *pivot*, on which the motion of a ball and socket may be made, with such a gradual yielding of the substance of the ligament, in whichever direction our spines are moved, as saves the body from violent shocks, and their dangerous consequences (*f*).—This ligamento-cartilaginous substance is firmly fixed to the horizontal surfaces of the bodies of the *vertebrae*, to connect them, in which it is assisted by a strong membranous ligament, which lines all their concave surface, and by still a stronger ligament that covers all their anterior convex surface.

We may lay it down as a general rule, notwithstanding some exceptions, That the *bodies* of the *vertebrae* are smaller, and more solid above; but as they descend, they appear larger and more spongy; and that the cartilages between them are thick, and the surrounding ligaments strong, in proportion to the largeness of the *vertebra*, and to the quantity of motion they perform: By which disposition, the greater weight is supported on the broadest best secured base, and the middle of our body is allowed a large and secure motion.

From each side of the body of each *vertebra*, a bony bridge is produced backwards, and to a side; from the posterior end of which, one slanting process rises, and another descends; the smooth, and what is generally the flattest side of each of these four processes, which are called the *oblique* (*g*), is covered with a smooth cartilage; and the two lower ones of each *vertebra* are fitted to, and articulated with, the two upper or ascending oblique processes of the *vertebra* below, having their articular ligaments fixed into the rough line round their edges.

From

(*f*) Medical essays and observ. vol. 5. art. 28.

(*g*) Articulatorii, minimi.

From between the oblique processes of each side, the *vertebra* is stretched out laterally into a process that is named *transverse*.

From the back-part of the roots of the two oblique, and of the transverse process of each side, a broad oblique bony plate is extended backwards; where these meet, the seventh process of the *vertebrae* takes its rise, and stands out backwards: This being generally sharp pointed and narrow edged, has therefore been called *spinal process*; from which this whole chain of bones has got its name.

Besides the common ligament which lines all the internal surface of the spinal processes, as well as of the bodies, there are particular ligaments that connect the bony bridges and processes of the contiguous *vertebrae* together.

The substance of the processes is considerably stronger and firmer, and has a thicker external plate than the bodies of the *vertebrae* have.

The seven processes form a concavity at their fore-part, which, joined to the one at the back-part of the bodies, makes a great hole; and the holes of all the *vertebrae* form a long large conduit (*b*), for containing the *spinal marrow*.—In the upper and lower edge of each lateral bridge, there is a notch. These are so adapted to each other in the contiguous *vertebrae*, as to form a round hole in each side between each two *vertebrae*, through which the nerves that proceed from the *spinal marrow* and its blood-vessels pass.

The articulations then of these *true vertebræ* are plainly double; for their bodies are joined, by the intervening cartilage above described; and their oblique processes being tipped with cartilages, are so connected by their ligaments, as to allow a small degree of motion to all sides. Hence it is evident, that their centre of motion is altered in different positions of the trunk: For when we bow forwards, the upper moved part bears entirely on the bodies of the *vertebrae*: If we bend back, the oblique processes support

(b) ιπα ευργε, εναν, Canalis.

port the weight: If we recline to one side, we rest upon the oblique processes of that side and part of the bodies: If we stand erect, all the bodies and oblique processes have their share in our support.

Hence it follows, 1. That because the joints of which the spine is composed are so numerous, the *spinal* marrow, nerves, blood-vessels, &c. are not liable to such compression and over-stretching in the motion of the trunk of the body, as they would otherwise be, since several *vertebrae* must be concerned in every motion of the spine; and therefore a very small curvature is made at the conjunction of any two *vertebrae* (*i*). 2. That an erect posture is the surest and firmest, because the surface of contact of the *fulcra* is largest, and the weight is most perpendicular to them (*k*). 3. That the muscles which move the spine, act with greater force in bringing the trunk to an erect posture, than in drawing it to any other: for in bending forwards, backwards, or to a side, the muscles which perform any of these actions are nearer the centre of motion; consequently the lever with which they act is shorter, than when the centre of motion is on the part of the *vertebra*, opposite to that where these muscles are inserted; which is the case in raising the trunk. This is extremely necessary; since, in the deflections of the spine from a perpendicular bearing, the weight of the body soon inclines it which way we design; whereas, in raising us erect, this great weight must be more than counteracted. 4. In calculating the force exerted by the muscles which move the spine, we should always make allowance for the action of the cartilages between the *vertebrae*, which, in every motion from an erect posture, must be stretched on one side, and compressed on the other, to both which they resist; whereas, in raising the trunk, these cartilages assist by their springy force (*l*). 5. We are hence naturally led into the reason

(*i*) Galen de *usu* part. lib. x2. cap. x2.

(*k*) Paaw de *ossib.* par. 2. cap. 2.

(*l*) Borelli de *motu animal.* pars 1. schol. ad propos. 58.—PARENT. *Histoire de l'acad. des sciences,* 1702.

of our height of stature increasing in the morning, and diminishing at night (*m*) : for the intermediate cartilages of the *vertebrae* being pressed all day long by the weight of our body, become more compact and thin in the evening ; but when they are relieved from this pressure in the night, they again expand themselves to their former thickness ; and seeing the bulk of any part must vary according to the different distension or repletion of the vessels composing it, we may understand how we become taller after a plentiful meal, and decrease after fasting or evacuations (*n*). 6. From the different articulations of the bodies, and oblique processes of the *vertebrae*, and the different strength of the ligaments, it is plain, that they are formed so as to allow much larger motion forwards than backwards ; this last being of much less use, and might be dangerous, by overstretching the large blood-vessels that are contiguous to the bodies of the *vertebrae* (*o*). 7. The intervertebral cartilages shrivelling as they become more solid by age, is the cause why old people generally bow forwards, and cannot raise their bodies to such an erect posture as they had in their youth.

The *true vertebrae* serve to give us an erect posture ; to allow sufficient and secure motion to the head, neck, and trunk of the body ; and to support and defend the bowels, and other soft parts.

At the ordinary time of birth, each *vertebra* consists of three bony pieces, connected by cartilages ; to wit, the *body*, which is not fully ossified, and a long crooked bone on each side : on which we see a small share of the bony bridge, the oblique processes compleat, the beginning transverse processes, and the oblique plate, but no spinal processes ; so that the teguments are in no danger of being hurt by the sharp ends of these spinal processes, while a child is in its bended

(*m*) Wall Philosoph. tractat. numb. 383. art. 1.

(*n*) Abbe Fontenelle Histoire de l'acad. des sciences, 1725.

(*o*) Galen de usu part. lib. I. cap. 16.

bended posture in the womb, nor while it is squeezed in the birth.

From this general mechanism of the spine, an account is easily deduced of all the different preternatural curvatures which the spine is capable of: for if one or more *vertebrae*, or their cartilages, are of unequal thickness in opposite sides, the spine must be reclined over to the thinner side; which now sustaining the greatest share of the weight, must still be more compressed, consequently hindered from extending itself in proportion to the other side, which, being too much freed of its burden, has liberty to enjoy a luxuriant growth. The causes on which such an inequality of thickness in different sides of the *vertebrae* depends, may vary: for, either it may be owing to an over-distension of the vessels of one side, and from thence a preternatural increase of the thickness of that part; or, which more commonly is the case, it may proceed from an obstruction of the vessels, by which the application of proper nourishment to the bony substance is hindered, whether that obstruction depends on the faulty disposition of the vessels or fluids; or if it is produced by an unequal mechanical pressure, occasioned by a paralytic weakness of the muscles and ligaments, or by a spasmodic over-action of the muscles on any side of the spine, or by people continuing long, or putting themselves frequently into any posture declining from the erect one: In all these cases, one common effect follows, to wit, the *vertebrae*, or their cartilages, or both, turn thick on that side where the vessels are free, and remain thin on the other side where the vessels are straitened or obstructed.—Whenever any morbid curvature is thus made, a second turn, but in an opposite direction to the former, must be formed; both because the muscles on the convex side of the spine being stretched, must have a stronger natural contraction to draw the parts to which their ends are fixed, and because the patient makes efforts to keep the centre of gravity of the body perpendicular to its base, that the muscles may be relieved

relieved from a constant violent contractile state, which always creates uneasiness and pain.

When once we understand how these crooked spines are produced, there is little difficulty in forming a just prognosis; and a proper method of cure may be easily contrived, which must vary as to the internal medicines, according to the different causes on which the disease depends. But one general indication must be pursued by surgeons; which is, to counteract the bending force, by increasing the compression on the convex part of the curvature, and diminishing it on the concave side; the manner of executing which in particular cases must be different, and requires a very accurate examination of the circumstances both of the disease and patient. In many such cases, I have found some simple directions, as to postures in which the patient's body should be kept, of very great advantage.

Though the *true vertebrae* agree in the general structure which I have hitherto described; yet, because of several specialities proper to a particular number, they are commonly divided into three classes, *viz. cervical, dorsal, and lumbar.*

The *cervical* (*a*) are the seven uppermost *vertebrae*; which are distinguished from the rest by these marks.—Their bodies are smaller and more solid than any others, and flattened on the fore-part, to make way for the *œsophagus*; or rather this flat figure is owing to the pressure of that pipe, and to the action of the *longi colli* and anterior *recti* muscles.—They are also flat behind, where small processes rise, to which the internal ligaments are fixed.—The upper surface of the body of each *vertebra* is made hollow, by a slanting thin process which is raised on each side:—The lower surface is also excavated, but in a different manner; for here, the posterior edge is raised a little, and the one before is produced a considerable way.—Hence we see how the cartilages between those bones are firmly connected, and their articulations are secure.

The

(a) Τραχηλού, αυχενος, colli.

The cartilages between these *vertebrae* are thick, especially at their fore-part; which is one reason why the *vertebrae* advance forward as they descend, and have larger motion.

The oblique processes of these bones of the neck more justly deserve that name than those of any other *vertebrae*. They are situated slanting; the upper ones having their smooth and almost flat surfaces facing obliquely backwards and upwards, while the inferior oblique processes have these surfaces facing obliquely forwards and downwards.

The transverse processes of these *vertebrae* are framed in a different manner from those of any other bones of the spine: For, besides the common transverse process rising from between the oblique processes of each side, there is a second one that comes out from the side of the body of each *vertebra*; and these two processes, after leaving a circular hole for the passage of the cervical artery and vein, unite, and are considerably hollowed at their upper part, with rising sides, to protect the nerves that pass in the hollow; and at last each side terminates in an obtuse point, for the insertion of muscles.

The spinal processes of these cervical bones stand nearly straight backwards, are shorter than those of any other *vertebrae*, and are forked or double at their ends; and hence allow a more convenient insertion to muscles.

The thick cartilages between the bodies of these *cervical vertebrae*, the obliquity of their *oblique processes*, and the shortness and horizontal situation of their *spinal processes*, all conspire to allow them large motion.

The holes between the bony cross bridges, for the passage of the nerves from the *spinal marrow*, have their largest share formed in the lowest of the two *vertebrae*, to which they are common.

So far most of the cervical *vertebrae* agree; but they have some particular differences, which oblige us to consider them separately.

The

The first, from its use of supporting the head, has the name of *atlas* (a); and is also called *epistrophea*, from the motion it performs on the second.

The *atlas*, contrary to all the other *vertebrae* of the spine, has no body; but, instead of it, there is a bony arch.—In the convex fore-part of which, a small rising appears, where the *musculi longi colli* are inserted; and, on each side of this protuberance, a small cavity may be observed, where the *recti interni minores* take their rise.—The upper and lower parts of the arch are rough and unequal, where the ligaments that connect this *vertebra* to the *os occipitis*, and to the second *vertebra*, are fixed.—The back-part of the arch is concave, smooth, and covered with a cartilage, in a recent subject, to receive the tooth-like process of the second *vertebra*.—In a first *vertebra*, from which the second has been separated, this hollow makes the passage for the *spinal* marrow to seem much larger than it really is: On each side of it a small rough sinuosity may be remarked, where the ligaments going to the sides of the tooth-like process of the following *vertebra* are fastened; and on each side, a small rough protuberance and depression is observable, where the transverse ligament, which secures the tooth-like process in the sinuosity, is fixed, and hinders that process from injuring the *medulla spinalis* in the flexions of the head.

The *atlas* has as little spinal process as body; but, instead thereof, there is a large bony arch, that the muscles which pass over this *vertebra* at that place might not be hurt in extending the head. On the back and upper part of this arch there are two depressions where the *recti postici minores* take their rise; and at the lower part are two other sinuosities, into which the ligaments which connect this bone to the following one are fixed.

The superior oblique processes of this *atlas* are large, oblong, hollow, and more horizontal than in any other *vertebra*.—They rise more in their external than internal

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(a) Ατραγαλος.

nal brim; by which their articulations with the *condyloid* processes of the *os occipitis* are firmer.—Under the external edge of each of these oblique processes, is the *fossa* or deep open channel, in which the vertebral arteries make the circular turn, as they are about to enter the great *foramen* of the occipital bone, and where the tenth pair of nerves goes out.—In several bodies, I have seen this *fossa* covered with bone.—The inferior oblique processes extending from within outwards and downwards, are large, concave, and circular. So that this *vertebra*, contrary to the other six, receives the bones with which it is articulated both above and below.

The transverse processes here are not much hollowed or forked, but are longer and larger than those of any other *vertebra* of the neck, for the origin and insertion of several muscles; of which those that serve to move this *vertebra* on the second, have a considerable lever to act with, because of the distance of their insertion from the *axis* of revolution.

The hole for the *spinal marrow* is larger in this than in any other *vertebra*, not only on account of the *marrow* being largest here, but also to prevent its being hurt by the motions of this *vertebra* on the second one.—This large hole, and the long transverse processes, make this the broadest *vertebra* of the neck.

The *condyles* of the *os occipitis* move forwards and backwards in the superior oblique processes of this *vertebra*; but from the figure of the bones forming these joints, it appears, that very little motion can here be allowed to either side; and there must be still less circular motion.

In new-born children, this *vertebra* has only the two lateral pieces ossified; the arch, which it has at its fore-part instead of a body, being cartilaginous.

The second *vertebra colli* is called *dentata*, from the tooth-like process on the upper part of its body. Some authors call it *epistrophea*, but improperly, since this designation is only applicable to the first, which moves on this as on an axis.

The

The body of this *vertebra* is somewhat of a pyramidal figure, being large, and produced downwards, especially at its fore-side, to enter into a hollow of the *vertebra* below; while the upper part has a square process with a small point standing out from it. This it is that is imagined to resemble a tooth (*a*), and has given name to the *vertebra*.—The side of this process, on which the hollow of the anterior arch of the first *vertebra* plays, is convex, smooth, and covered with a cartilage; and it is of the same form behind, for the ligament, which is extended transversely from one rough protuberance of the first *vertebra* to the other, and is cartilaginous in the middle, to move on it.—A ligament likewise goes out in an oblique transverse direction, from each side of the *processus dentatus*, to be fixed at its other end to the first *vertebra*, and to the occipital bone: And another ligament rises up from near the point of the process to the *os occipitis*.

The superior oblique processes of this *vertebra dentata* are large, circular, very nearly in an horizontal position, and slightly convex, to be adapted to the inferior oblique processes of the first *vertebra*.—A moveable cartilage is said by some authors to be interposed between these oblique processes of the first and second *vertebra*; but I could never find it.—The inferior oblique processes of this *vertebra dentata* answer exactly to the description given of those common to all the cervical *vertebrae*.

The transverse processes of the *vertebra dentata* are short, very little hollowed at their upper part, and not forked at their ends; and the canals through which the cervical arteries pass, are reflected outwards about the middle substance of each process; so that the course of these vessels may be directed towards the transverse processes of the first *vertebra*.—Had this curvature of the arteries been made in a part so moveable as the neck is, while they were not defended by a bone, and fixed to that bone, scarce a

M 2

motion

(a) Conoides, pyrenoides, odontoides.

motion could have been performed without the utmost hazard of compression, and a stop put to the course of the liquids, with all its train of bad consequences. Hence we observe this same mechanism several times made use of, when there is any occasion for a sudden curvature of a large artery. This is the third remarkable instance of it we have seen. The first was the passage of the *carotids* through the *temporal* bones; and the second was that lately described in the vertebral arteries, turning round the oblique processes of the first *vertebra*, to come at the great hole of the occipital bone.

The spinal process of this *vertebra dentata* is thick, strong, and short, to give sufficient origin to the *musculi recti majores*, and *obliqui inferiores*, and to prevent the contusion of these and other muscles in pulling the head back.

This second *vertebra* consists, at the birth, of four bony pieces: For, besides the three which I already mentioned as common to all the *vertebrae*, the tooth-like process of this bone is begun at this time to be ossified in its middle, and is joined as an appendix to the body of the bone.—Lest this appendix be bented or displaced, nurses ought to keep the heads of new-born children from falling too far backwards by *stay-bands*, or some such means, till the muscles attain strength sufficient to prevent that dangerous motion.

When we are acquainted with the structure and articulations of the first and second *vertebrae*, and know exactly the strength and connection of their ligaments, there is no difficulty in understanding the motions that are performed upon or by the first; though this subject was formerly matter of hot dispute among some of the greatest anatomists (b). It is none of my purpose at present to enter into a detail of the reasons advanced by either party; but to explain the fact, as any one may see it, who will remove the muscles, which, in a recent subject, hinder

the

(b) See Eustach. de motu capitis.

the view of these two joints, and then will turn the head into all the different positions it is capable of. The head may then be seen to move forwards and backwards on the first *vertebra*, as was already said, while the *atlas* performs the *circumgyratio* upon the second *vertebra*; the inferior oblique processess of the first *vertebra* shuffling easily in a circular way on the superior oblique processess of the second, and its body or anterior arch having a rotation on the tooth-like process, by which the perpendicular ligament that is sent from the point of the tooth-like process to the occipital bone is twisted, while the lateral ligaments, that fix the *processus dentatus* to the sides of the first *vertebra*, and to the *os occipitis*, are very differently affected; for the one upon the side towards which the face is turned by the *circumgyratio*, is much shortened and lax, while the opposite one is stretched and made tense, and, yielding at last no more, prevents the head from turning any farther round on this *axis*. So that these lateral ligaments are the proper *moderators* of the *circumgyratio* of the head here, which must be larger or smaller, as these ligaments are weaker or stronger, longer or shorter, and more or less capable of being stretched.—Besides the revolution on this *axis*, the first *vertebra* can move a small way to either side; but is prevented from moving backwards and forwards, by its anterior arch, and by the cross ligament, which are both closely applied to the tooth-like process. Motion forwards here, would have been of very bad consequence, as it would have brought the beginning of the *spinal marrow* upon the point of the tooth-like proceſſ.

The rotatory motion of the head is of great use to us on many accounts, by allowing us to apply quickly our organs of the fenses to objects: And the *axis* of rotation was altogether proper to be at this place; for, if it had been at a greater distance from the head, the weight of the head, if it had at any time been removed from a perpendicular bearing to the

small very moveable joint, and thereby had acquired a long lever, would have broke the ligaments at every turn inconsiderately performed; or these ligaments must have been formed much stronger than could have been connected to such small bones. Neither could this circular motion be performed on the first *vertebra* without danger, because the immovable part of the *medulla oblongata* is so near, as at each large turn, the beginning of the *spinal* marrow would have been in danger of being twisted, and of suffering by the compression this would have made on its tender fibrils.

It is necessary to observe, that the *lateral* or *moderator* ligaments confine so much the motion of the first *vertebra* upon the second, that, though this joint may serve us on several occasions, yet we are often obliged to turn our faces farther round, than could be done by this joint alone, without the greatest danger of twisting the spinal marrow too much, and also of luxating the oblique processes; therefore, in large turns of this kind, the rotation is assisted by all the *vertebrae* of the neck and loins; and if this is not sufficient, we employ most of the joints of the lower extremities.—This combination of a great many joints towards the performance of one motion, is also to be observed in several other parts of the body; notwithstanding such motions being generally said to be performed by some single joint only.

The third *vertebra* of the neck is by some called *axis*: but this name is applied to it with much less reason than to the second.—This third, and the three below, have nothing particular in their structure; but all their parts come under the general description formerly given, each of them being larger as they descend.

The seventh (*c*) *vertebra* of the neck is near to the form of those of the back, having the upper and lower surfaces of its body less hollow than the others:—The oblique processes are more perpendicular; and the transverse process is more developed.

(c) *Atlas quibusdam, maxima, magna vertebra, prominens,*

lar;—neither spinal nor transverse processes are forked.—This seventh and the sixth *vertebra* of the neck have the hole in each of their transverse processes more frequently divided by a small cross bridge, that goes between the cervical vein and artery, than any of the other *vertebrae*.

The twelve *dorsal* (*d*) may be distinguished from the other *vertebrae* of the spine by the following marks.

Their bodies are of a middle size, betwixt those of the neck and loins;—they are more convex before than either of the other two sorts; and are flattened laterally by the pressure of the ribs, which are inserted into small cavities formed in their sides. This flattening on their sides, which makes the figure of these *vertebrae* almost an half oval, is of good use; as it affords a firm articulation to the ribs, allows the *trachea arteria* to divide at a small angle, and the other large vessels to run secure from the action of the vital organs.—These bodies are more concave behind than any of the other two classes.—Their upper and lower surfaces are horizontal.

The cartilages interposed between the bodies of these *vertebrae* are thinner than in any other of the true *vertebrae*; and contribute to the concavity of the spine in the thorax, by being thinnest at their fore-part.

The *oblique* processes are placed almost perpendicular; the upper ones slanting but a little forwards, and the lower ones slanting as much backwards.—They have not as much convexity or concavity as is worth remarking.—Between the oblique processes of opposite sides, several sharp processes stand out from the upper and lower parts of the plates which join to form the spinal process; into these sharp processes strong ligaments are fixed, for connecting the *vertebrae*.

The

(d) οφαλος, μεταπησι, νερο, υποφαχνια, αντιστρι, πεστος, τεργι.

The *transverse* processes of the *dorsal vertebrae* are long, thicker at their ends than in the middle, and turned obliquely backwards; which may be owing to the pressure of the ribs, the tubercles of which are inserted into a depression near the end of these processes.

The *spinal* processes are long, small-pointed, and sloping downwards and backwards; from their upper and back-part a ridge rises, which is received by a small channel in the fore-part of the spinal process immediately above, which is here connected to it by a ligament.

The *conduit* of the *spinal marrow* is here more circular, but, corresponding to the size of that cord, is smaller than in any of the other *vertebrae*, and a larger share of the holes in the bony bridges, for the transmission of the nerves, is formed in the *vertebra* above, than in the one below.

The connection of the *dorsal vertebrae* to the ribs, the thinness of their cartilages, the erect situation of the oblique processes, the length, sloping, and connection of the spinal processes, all contribute to restrain these *vertebrae* from much motion, which might disturb the actions of the heart and lungs; and, in consequence of the little motion allowed here, the *intervertebral* cartilages sooner shrivel, by becoming more solid: And therefore, the first remarkable curvature of the spine observed, as people advance to old age, is in the least-stretched *vertebrae* of the back; or old people first become round-shouldered.

The bodies of the four uppermost *dorsal vertebrae* deviate from the rule of the *vertebrae* becoming larger as they descend; for the first of the four is the largest, and the other three below gradually become smaller, to allow the *trachea* and large vessels to divide at smaller angles.

The two uppermost *vertebrae* of the back, instead of being very prominent forwards, are flattened by the action of the *musculi longi colli* and *recti majoris*.

The

The proportional size of the two little depressions in the body of each *vertebra*, for receiving the heads of the ribs, seems to vary in the following manner; the depression on the upper edge of each *vertebra* decreases as far down as the fourth, and after that increases.

The transverse processes are longer in each lower *vertebra* to the seventh or eighth, with their smooth surfaces, for the tubercles of the ribs, facing gradually more downwards; but afterwards as they descend they become shorter, and the smooth surfaces are directed more upwards.

The spinous processes of the *vertebrae* of the back become gradually longer and more slanting from the first, as far down as the eighth or ninth *vertebra*; from which they manifestly turn shorter and more erect.

The first (*f*) *vertebra*, besides an oblong hollow in its lower edge, that assists in forming the cavity wherein the second rib is received, has the whole cavity for the head of the first rib formed in it.

The second has the name of *axillary* (*g*), without any thing particular in its structure.

The eleventh (*b*) often has the whole cavity for the eleventh rib in its body, and wants the smooth surface on each transverse process.

The twelfth (*i*) always receives the whole head of the last rib, and has no smooth surface on its transverse processes, which are very short.—The smooth surfaces of its inferior oblique processes face outwards as the *lumbar* do.—And we may say, in general, that the upper *vertebrae* of the back lose gradually their resemblance to those of the neck, and the lower ones come nearer to the figure of the *lumbar*.

The articulation of the *vertebrae* of the back with the ribs, shall be more particularly considered, after the ribs are described. Only it may be proper now

(*f*) Λοφία, gutturalis.

(*g*) Μασχαλιστήρ.

(*b*) Αρρενις, in neutram partem inclinans.

(*i*) Διασωστήρ, præcinctus.

to remark, that the ligaments which serve that articulation assist in connecting the *vertebrae*.

The lowest order of the *true vertebrae* is the *lumbar* (*k*), which are five bones, that may be distinguished from any others by these marks: 1. Their bodies, though of a circular form at their fore-part, are somewhat oblong from one side to the other; which may be occasioned by the pressure of the large vessels, the *aorta* and *cava*, and of the *viscera*. The *epiphyses* on their edges are larger, and therefore the upper and lower surfaces of their bodies are more concave than in the *vertebrae* of the back. 2. The cartilages between these *vertebrae* are much the thickest of any, and render the spine convex within the *abdomen*, by their greatest thickness being at their fore-part. 3. The oblique processess are strong and deep; those in opposite sides being almost placed in parallel planes; the superior, which are concave, facing inwards, and the convex inferior ones facing outwards: and therefore each of these *vertebrae* receives the one above it, and is received by the one below; which is not so evident in the other two classes already described. 4. Their transverse processess are small, long, and almost erect, for allowing large motion to each bone, and sufficient insertion to muscles, and for supporting and defending the internal parts. 5. Betwixt the roots of the superior oblique and transverse processess, a small protuberance may be observed, where some of the muscles that raise the trunk of the body are inserted. 6. Their spinal processess are strong, straight, and horizontal, with broad flat sides, and a narrow edge above and below; this last being depressed on each side by muscles. And at the root of these edges, we see rough surfaces for fixing the ligaments. 7. The canal for the numerous cords, called *cauda equina*, into which the spinal marrow divides, is rather larger in these bones than what contains that marrow in the *vertebrae* of the back. 8. The holes for the passage of the nerves are more equally formed

(k) οσφυος ιξυος, λοιπων, renum, lumborum.

ed out of both the contiguous *vertebrae* than in the other classes; the upper one furnishes however the larger share of each hole.

The thick cartilages between these *lumbar vertebrae*, their deep oblique processes, and their erect spinal processes, are all fit for allowing large motion; though it is not so great as what is performed in the neck; which appears from comparing the arches which the head describes when moving on the neck, or the loins only.

The *lumbar vertebrae* as they descend, have their oblique processes at a greater distance from each other, and facing more backwards and forwards.

Both transverse and spinal processes of the middle-most *vertebrae* of the loins are longest and thickest; in the *vertebrae* above and below they are less: So that these processes of the first (*l*) and fifth (*m*) are the least, to prevent their striking on the ribs or *ossa ilium*, or their bruising the muscles in the motions of the spine.

The *epiphyses* round the edges of the bodies of the *lumbar vertebrae* are most raised in the two lowest, which consequently make them appear hollower in the middle than the others are.

The body of the fifth *vertebra* is rather thinner than that of the fourth.—The spinal process of this fifth is smaller, and the oblique processes face more backwards and forwards than in any other *lumbar vertebra*.

After considering the structure of the particular *vertebrae*, and their mutual connection, we may observe a solicitous care taken that they shall not be disjoined, but with great difficulty; for besides being connected by strong ligaments proportioned to the forces which are to be resisted, their bodies either enter so into each other, as to prevent their being displaced any way, as in the *vertebrae* of the neck; or they are propped on all sides, as these of the back are by

(*l*) Νεφήτης, renalis.

(*m*) Ασχαλίτης, fulcions.

by the ribs; or their surfaces of contact are so broad, as to render the separation almost impracticable, as in the *loins*; while the depth and articulation of the oblique processes are exactly proportioned to the quantity of motion which the other parts of the bones allow, or the muscles can perform: Yet, as these oblique processes are small, and therefore not capable of so secure a conjunction, as the larger bodies, they may sooner yield to a disjoining force; but then their dislocation is not of near so bad consequence as the separation of the bodies would be. For, by the oblique processes being dislocated, the muscles, ligaments, and *spinal marrow*, are indeed stretched; but this marrow must be compressed, or entirely destroyed, when the body of the *vertebra* is removed out of its place.

The *FALSE VERTEBRAE* compose the under pyramid of the *spine*. They are distinguished from the bones already described justly enough by this epithet of *false*; because though each bone into which they can be divided in young people, resembles the *true vertebrae* in figure, yet none of them contribute to the motion of the trunk of the body; they being intimately united to each other in adults, except at the lower part, where they are moveable; whence they are commonly divided into two bones, *os sacrum* and *coccygis*.

OS SACRUM (*n*), is so called, from being offered in sacrifice by the ancients, or rather because of its largeness in respect of the other *vertebrae*.—This bone is of an irregular triangular shape, broad above, narrow below, convex behind, for the advantageous origin of the muscles that move the *spine* and thigh backwards; and concave behind, for enlarging the cavity of the *pelvis*.—Four transverse lines, of a colour different from the rest of the bone which are seen on its fore-part, are the marks of division of the five

(n) Ιερον, σκονδυλος μεγας Hippocrat. υπεσπονδυλον, oribas, πλατυ, latum, os clunium, clavium.

five different bones of which it consists in young persons.

The fore-part of the *os sacrum*, analogous to the bodies of the *true vertebrae*, is smooth and flat, to allow a larger space for the contained bowels, without any danger of hurting them; or this flat figure may be owing to the equal pressure of these bowels, particularly of the last gut.—The back-part of it is almost straight, without so large a cavity as the *vertebrae* have; because the spinal marrow, now separated into the *cauda equina*, is small.—The bridges between the bodies and processes of this bone, are much thicker, and in proportion shorter, than in the former class of bones.—The strength of these cross bridges is very remarkable in the three upper bones, and is well proportioned to the incumbent weight of the trunk of the body, which these bridges sustain in a transverse, consequently an unfavourable situation, when the body is erect.

There are only two oblique processes of the *os sacrum*; one standing out on each side from the upper part of the first bone.—Their plain erect surfaces face backwards, and are articulated with the inferior oblique processes of the last *vertebra* of the loins, to which each of these processes is connected by a strong ligament, which rises from a scabrous cavity round their roots, where mucilaginous glands are also lodged.—Instead of the other oblique processes of this bone, four rough tubercles are to be seen on each side of its surface behind, from which the *musculus sacer* has its origin.

The transverse processes here are all grown together into one large strong oblong process on each side, which, so far as it answers to the first three bones, is very thick, and divided into two irregular cavities, by a long perpendicular ridge.—The foremost of the two cavities has commonly a thin cartilaginous skin covering it in the recent subject, and is adapted to the unequal protuberance of the *os ilium*; and a strong ligament connects the circumference of

N these

these surfaces of the two bones.—The cavity behind is divided by a transverse ridge into two, where strong ligamentous strings that go from this bone to the *os ilium*, with a cellular substance containing *mucus*, are lodged.

The transverse processes of the two last bones of the *os sacrum* are much smaller than the former.—At their back-part, near their edge, a knob and oblong flat surface give rise to two strong ligaments which are extended to the *os ischium*; and are therefore called *sacro-sciatic*.

The spinal processes of the three uppermost bones of the *os sacrum* appear short, sharp, and almost erect, while the two lower ones are open behind; and sometimes a little knob is to be seen on the fourth, though generally it is bifurcated, without the two legs meeting into a spine; in which condition also the first is often to be seen; and sometimes none of them meet, but leave a *sinus*, or rather *fossa*, instead of a canal (o).—The *musculus latissimus* and *longissimus dorsi*, *sacro-lumbalis* and *glutaeus maximus*, have part of their origins from these spinal processes.

The canal between the bodies and processes of this bone, for the *cauda equina*, is triangular; and becomes smaller as it descends, as the *cauda* also does.—Below the third bone, this passage is no more a complete bony canal, but is open behind; and is only there defended by a strong ligamentous membrane stretched over it, which, with the muscles that cover it, and are very prominent on each side, is a sufficient defence for the bundle of nerves within.

At the root of each oblique process of this bone, the notch is conspicuous, by which, and such another in the last *vertebra* of the loins, a passage is left for the twenty-fourth spinal nerve; and, in viewing the *os sacrum*, either before or behind, four large holes appear in each side, in much the same height, as where the marks of the union of its several bones remain. Some of the largest nerves of the body pass through

(o) Verheyen Anat. tract. 5. cap. 9.—Sue Trad. d'osteol. p. 127.

through the anterior holes; and superficial grooves running outwards from them in different directions, shew the course of these nerves.—From the intervals of these grooves, the *pyriformis* muscle chiefly rises.—The holes in the back-part of the bone are covered by membranes which allow small nerves to pass through them.—The two uppermost of these holes, especially on the fore-side, are the largest; and as the bone descends, the holes turn smaller. Sometimes a notch is only formed at the lower part in each side of this bone; and in other subjects there is a hole common to it and the *os coccygis*, through which the twenty-ninth pair of spinal nerves passes; and frequently a bony bridge is formed on the back-part of each side by a process sent up from the back-part of the *os coccygis*, and joined to the little knobs which the last bone of the *os sacrum* has instead of a spinal process. Under this bridge or *jugum*, the twenty-ninth pair of spinal nerves runs in its course to the common holes just now described.

The upper part of the body of the first bone resembles the *vertebrae* of the loins; but the small fifth bone is oblong transversely, and hollow in the middle of its lower surface.

The substance of the *os sacrum* is very spongy, without any considerable solid external plates, and is lighter proportionally to its bulk than any other bone in the body; but is secured from injuries by the thick muscles that cover it behind, and by the strong ligamentous membranes that closely adhere to it.—As this is one of the most remarkable instances of this sort of defence afforded a soft weak bone, we may make the general observation, That, where-ever we meet with such a bone, one or other, or both these defences are made use of, the first to ward off injuries, and the second to keep the substance of the bone from yielding too easily.

This bone is articulated above to the last *vertebra* of the loins, in the manner that the *lumbar vertebrae* are joined; and therefore the same motions may be per-

formed here.—The articulation of the lower part of the *os sacrum* to the *os coccygis*, seems well enough adapted for allowing considerable motion to this last bone, was it not much confined by ligaments. Laterally, the *os sacrum* is joined to the *os ilium* by an immovable *synchondrosis*, or what almost deserves the name of a suture; for the cartilaginous crust on the surface of the bones is very thin, and both their surfaces are so scabrous and unequal, as to be indented into each other: which makes such a strong connection, that great force is required to separate them, after all the muscles and ligaments are cut.—Frequently the two bones grow together in old subjects.

The uses of the *os sacrum* are, to serve as the common base and support of the trunk of the body, to guard the nerves proceeding from the end of the spinal marrow, to defend the back-part of the *pelvis*, and to afford sufficient origin to the muscles which move the trunk and thigh.

The bones that compose the *os sacrum* of infants, have their bodies separated from each other by a thick cartilage; and, in the same manner as the *true vertebrae*, each of them consists of a body and two lateral plates, connected together by cartilages; the ends of the plates seldom being contiguous behind.

OS COCCYGIS (a), or *rump-bone*, is that triangular chain of bones depending from the *os sacrum*; each bone becoming smaller as they descend, till the last ends almost in a point. The *os coccygis* is convex behind, and concave before; from which crooked pyramidal figure, which was thought to resemble a cuckoo's beak, it has got its name.

This bone consists of four pieces in people of middle age:—In children, very near the whole of it is cartilage: In old subjects, all the bones are united, and become frequently one continued bone with the *os sacrum*.

The highest of the four bones is the largest, with shoulders extended farther to each side than the end of

(a) οροπενυγιον ὄφρος, caudæ os, spondylum, os cuculi.

of the *os sacrum*; which enlargement should, in my opinion, serve as a distinguishing mark to fix the limits of either bone; and therefore should take away all dispute about reckoning the number of bones, of which one or other of these two parts of the *false vertebrae*, is composed; which dispute must still be kept up, so long as the numbering five or six bones in the *os sacrum* depends upon the uncertain accident of this broad-shouldered little bone being united to or separated from it.—The upper surface of this bone is a little hollow.—From the back of that bulbous part called its *shoulders*, a process often rises up on each side, to join with the bifurcated spine of the fourth and fifth bones of the *os sacrum*, to form the bony bridge mentioned in the description of the *os sacrum*.—Sometimes these shoulders are joined to the sides of the fifth bone of the *os sacrum*, to form the hole in each side common to these two bones, for the passage of the twenty-ninth pair of spinal nerves.—Immediately below the shoulders of the *os coccygis*, a notch may be remarked in each side, where the thirtieth pair of the spinal nerves passes.—The lower end of this bone is formed into a small head, which very often is hollow in the middle.

The three lower bones gradually become smaller, and are spongy; but are strengthened by a strong ligament which covers and connects them.—Their ends, by which they are articulated, are formed in the same manner as those of the first bone are.

Between each of these four bones of young subjects, a cartilage is interposed; therefore their articulation is analogous to that of the bodies of the *vertebrae* of the neck: For, as has been above remarked, the lower end of the *os sacrum*, and of each of the three superior bones of the *os coccygis*, has a small depression in the middle; and the upper part of all the bones of the *os coccygis* is a little concave, and consequently the interposed cartilages are thickest in the middle, to fill up both cavities; by which they connect the bones more firmly.—When the cartilages

ossify, the upper end of each bone is formed into a cavity, exactly adapted to the protuberant lower end of the bone immediately above.—From this sort of articulation, it is evident, that, unless when these bones grow together, all of them are capable of motion; of which, the first and second, especially this last, enjoys the largest share.

The lower end of the fourth bone terminates in a rough point, to which a cartilage is appended.

To the sides of these bones of the *os coccygis*, the *coccygæi* muscles (*b*), and part of the *levatores ani*, and of the *glutæi maximi*, are fixed.

The substance of these bones is very spongy, and in children cartilaginous; there being only a part of the first bone ossified in a new-born infant.—Since therefore the *intestinum rectum* of children is not so firmly supported as it is in adults, this may be one reason why they are more subject to a *procidentia ani* than old people (*c*).

From the description of this bone, we see how little it resembles the *vertebrae*; since it seldom has processes, never has any cavity for the *spinal marrow*, nor holes for the passage of nerves.—Its connection hinders it to be moved to either side; and its motion backwards and forwards is much confined: Yet as its ligaments can be stretched by a considerable force, it is a great advantage in the excretion of the *foeces alvinae*, and much more in child-bearing, that this bone should remain moveable: and the right management of it, in delivering women, may be of great benefit to them (*d*).—The mobility of the *os coccygis* diminishing as people advance in age, especially when its ligaments and cartilages have not been kept flexible by being stretched, is probably one reason why the women, who are old maids before they marry, have generally hard labour in child-bed.

The

(*b*) Douglas, Myograph. chap. 40.—Eustach. tab. 36. No. 45. 20.

(*c*) Spigel. de humani corp. fabric. lib. 2. cap. 22.—Paaw, de ossib. par. 2. cap. 3.

(*d*) Paaw, ibid.—Deventer, Operat. chirurg. cap. 27.

The *os coccygis* serves to sustain the *intestinum rectum*; and, in order to perform this office more effectually, it is made to turn with a curve forwards; by which also the bone itself, as well as the muscles and teguments, is preserved from any injury, when we sit with our body reclined back.

The second part of the trunk of the skeleton, the *PELVIS*, is the cylindrical cavity at the lower part of the *abdomen*, formed by the *os sacrum*, *os coccygis*, and *ossa innominata*; which last therefore fall now in course to be examined.

Though the name of *OSSA INNOMINATA* (*e*) contributes nothing to the knowledge of their situation, structure or office; yet they have been so long and universally known by it, that there is no occasion for changing it.—They are two large broad bones, which form the fore-part and sides of the *pelvis*, and the lower part of the sides of the *abdomen*.—In children each of these bones is evidently divided into three; which are afterwards so intimately united, that scarce the least mark of their former separation remains: This notwithstanding, they are described as consisting each of three bones, to wit, the *os ilium*, *ischium*, and *pubis*; which I shall first describe separately, and then shall consider what is common to any two of them, or to all the three.

OS ILIUM (*f*), or *baunch-bone*, is situated highest of the three, and reaches as far down as one third of the great cavity into which the head of the thigh-bone is received.

The external side of this bone is unequally convex, and is called its *dorsum*;—the internal concave surface is by some (but improperly) named its *costa*.—The semicircular edge at the highest part of this bone, which is tipped with a cartilage in the recent subject, is named the *spine*, into which the external or descending oblique muscle of the *abdomen* is inserted; and from it the internal ascending oblique and the trans-

(e) Σκελεόν, προσφυστής, sacro conjuncta.

(f) Διαγονων, κηφεγυ, scaphium, lumbare, clunium, clavium, anchæ.

verse muscles of the belly, with the *gluteus maximus*, *quadratus lumborum*, and *latissimus dorsi*, have their origin. Some (*a*) are of opinion, that it is only the tendinous crust of all these muscles, and not a cartilage, as commonly alledged, that covers this bony edge.—The ends of the spine are more prominent than the surface of the bone below them; therefore are reckoned processes.—From the anterior spinal process, the *sartorius* and *fascialis* muscles have their rise, and the outer end of the doubled tendon of the external oblique muscle of the *abdomen*, commonly called *Fallopian's* or *Poupart's* ligament, is fixed to it.—The inside of the posterior spinal process, and of part of the spine forward from that, is made flat and rough where the *sacro-lumbalis* and *longissimus dorsi* rise; and to its outside ligaments, extended to the *os sacrum* and transverse processess of the fifth and fourth *vertebrae* of the loins, are fixed (*b*).—Below the anterior spinal process another protuberance stands out, which, by its situation, may be distinguished from the former, by adding the epithet of *inferior*, where the *musculus rectus tibiae* has its origin (*c*).—Betwixt these two anterior processess the bone is hollowed where the beginning of the *sartorius* muscle is lodged.—Below the posterior spinal process, a second protuberance of the edge of this bone is in like manner observable, which is closely applied to the *os sacrum*.—Under this last process a considerable large niche is observable in the *os ilium*; between the sides of which and the strong ligament that is stretched over from the *os sacrum* to the sharp-pointed process of the *os ischium* of the recent subject, a large hole is formed, through which the *musculus pyriformis*, the great sciatic nerve, and the posterior crural vessels pass, and are protected from compression.

The external broad side or *dorsum* of the *os ilium* is a little (*a*) Winflow, Exposition anatomique du corps humain, traité des. os frais, § 96.

(*b*) Weitbrecht, Syndesmolog. sect. 4. § 39. 40. 46. 47.

(*c*) Baker; Curs. osteolog. demonstr. 3.

a little hollow towards the fore-part; farther back it is as much raised; then is considerably concave; and, lastly, it is convex. These inequalities are occasioned by the actions of the muscles that are situated on this surface.—From behind the uppermost of the two anterior spinal processess, in such bones as are strongly marked by the muscles, a semicircular ridge is extended to the hollow passage of the sciatic nerve. Between the spine and this ridge, the *glutaeus medius* takes its rise. Immediately from above the lowest of the anterior spinal processess, a second ridge is stretched to the niche. Between this and the former ridge, the *glutaeus minimus* has its origin.—On the outside of the posterior spinal processess, the *dorsum* of the *os ilium* is flat and rough, where part of the *musculus glutaeus maximus* and *pyriformis* rises.—The lowest part of this bone is the thickest, and is formed into a large cavity with high brims, to assist in composing the great *acetabulum*; which shall be considered, after all the three bones that constitute the *os innominatum*, are described.

The internal surface of the *os ilium* is concave in its broadest fore-part, where the internal iliac muscle has its origin, and some share of the *intestinum ilium* and *colon* is lodged.—From this large hollow, a small sinuosity is continued obliquely forwards, at the inside of the anterior inferior spinal process, where part of the *psoas* and *iliacus* muscles, with the crural vessels and nerves, pass.—The large concavity is bounded below by a sharp ridge, which runs from behind forwards; and being continued with such another ridge of the *os pubis*, forms a line of partition between the *abdomen* and *pelvis*.—Into this ridge the broad tendon of the *psoas parvus* is inserted.

All the internal surface of the *os ilium*, behind this ridge, is very unequal: For the upper part is flat, but spongy, where the *sacro-lumbalis* and *longissimus dorsi* rise.—Lower down, there is a transverse ridge from which ligaments go out to the *os sacrum*.—Immediately below this ridge, the rough unequal cavities

ties and prominences are placed, which are exactly adapted to those described on the side of the *os sacrum*.—In the same manner, the upper part of this rough surface is porous, for the firmer adhesion of the ligamentous cellular substance; while the lower part is more solid, and covered with a thin cartilaginous skin, for its immovable articulation with the *os sacrum*.—From all the circumference of this large unequal surface, ligaments are extended to the *os sacrum*, to secure more firmly the conjunction of these bones.

The passages of the medullary vessels are very conspicuous, both in the *dorsum* and *costa* of many *ossa ilium*; but in others they are inconsiderable.

The posterior and lower parts of these bones are thick; but they are generally exceeding thin and compact at their middle, where they are exposed to the actions of the *musculi glutaei* and *iliacus internus*, and to the pressure of the bowels contained in the belly.—The substance of the *ossa ilium* is mostly cellular, except a thin external table.

In a ripe child, the spine of the *os ilium* is cartilaginous, and is afterwards joined to the bone in form of an *epiphysis*. The large lower end of this bone is not compleatly ossified.

OS ISCHIUM (d) or *hip-bone*, is of a middle bulk between the two other parts of the *os innominatum*, is situated lowest of the three, and is of a very irregular figure.—Its extent might be marked by an horizontal line drawn near through the middle of the *acetabulum*; for the upper bulbous part of this bone forms some less than the lower half of that great cavity, and the small leg of it rises to much the same height on the other side of the great hole common to this bone and the *os pubis*.

From the upper thick part of the *os ischium*, a sharp process, called by some *spinous*, stands out backwards, from which chiefly the *musculus coccygeus* and *superior gemellus*, and part of the *levator ani*, rise; and the anterior

(d) *Coxæ, coxendicis, pixis.*

anterior or internal *sacro-sciatic* ligament is fixed to it.—Between the upper part of this ligament and the bones, it was formerly observed that the *pyriform* muscle, the posterior crural vessels, and the sciatic nerve, pass out of the *pelvis*.—Immediately below this process a sinuosity is formed for the tendon of the *musculus obturator internus*.—In a recent subject, this part of the bone, which serves as a pulley on which the *obturator* muscle plays, is covered with a ligamentous cartilage, that, by two or three small ridges, points out the interstices of the fibres in the tendon of this muscle.—The outer surface of the bone at the root of this spinous process is made hollow by the *pyriformis* or *iliacus externus* muscle.

Below the sinuosity for the *obturator* muscle, is the great knob or *tuberosity*, covered with cartilage or tendon (*a*).—The upper part of the tuberosity gives rise to the inferior *gemellus* muscle.—To a ridge at the inside of this, the external or posterior *sacro-sciatic* ligament is so fixed, that between it, the internal ligament, and the sinuosity of the *os ischium*, a passage is left for the internal *obturator* muscle.—The upper thick smooth part of the *tuber*, called by some its *dorsum*, has two oblique impressions on it. The inner one gives origin to the long head of the *biceps flexor tibiae* and *seminervosus* muscles, and the *semi-membranosus* rises from the exterior one, which reaches higher and nearer the *acetabulum* than the other.—The lower, thinner, more scabrous part of the knob which bends forwards, is also marked with two flat surfaces, whereof the internal is what we lean upon in sitting, and the external gives rise to the largest head of the *triceps adductor femoris*.—Between the external margin of the tuberosity and the great hole of the *os innominatum*, there is frequently an obtuse ridge extended down from the *acetabulum*, which gives origin to the *quadratus femoris*.—As the *tuber* advances forwards, it becomes smaller, and is rough, for the origin of the *musculus transversalis* and *erector penis*.

(*a*) Winslow Exposition anat. des os frais, § 96.

penis.—The small leg of it, which mounts upwards to join the *os pubis*, is rough and prominent at its edge, where the two lower heads of the *triceps* or *quadriceps adductor femoris* take their rise.

The upper and back-part of the *os ischium* is broad and thick; but its lower and fore-part is narrower and thinner.—Its substance is of the structure common to broad bones.

The *os ilium* and *pubis* of the same side are the only bones which are contiguous to the *os ischium*.

The part of the *os ischium* which forms the *acetabulum*, the spinous process, the great *tuber*, and the recurved leg, are all cartilaginous at birth.—The *tuber*, with part of the leg, or process above it, becomes an epiphysse before this bone is fully formed.

The *OS PUBIS* (*b*), or *bare-bone*, is the least of the three parts of the *os innominatum*, and is placed at the upper fore-part of it.—The thick largest part of this bone is employed in forming the *acetabulum*; from which becoming much smaller, it is stretched inwards to its fellow of the other side, where again it grows larger, and sends a small branch downwards to join the end of the small leg of the *os ischium*.—The upper fore-part of each *os pubis* is tuberous and rough where the *musculus rectus* and *pyramidalis* are inserted.—From this a ridge is extended along the upper edge of the bone, in a continued line with such another of the *os ilium*, which divides the *abdomen* and *pelvis*. The ligament of *Fallopian* is fixed to the internal end of this ridge; and the smooth hollow below it, is made by the *psoas* and *iliacus internus* muscles passing with the anterior crural vessels and nerves behind the ligament.—Some way below the former ridge, another is extended from the tuberous part of the *os pubis* downwards and outwards towards the *acetabulum*; between these two ridges the bone is hollow and smooth, for lodging the head of the *pectineus* muscle.—Immediately below, where the lower ridge is to take the turn downwards, a winding
niche

(b) ήβης, pectinis, penis, pudibundum, fenestratum.

niche is made, which is comprehended in the great *foramen* of a skeleton, but is formed into a hole by a subtended ligament in the recent subject, for the passage of the posterior crural nerve, an artery, and a vein.—The internal end of the *os pubis* is rough and unequal, for the firmer adhesion of the thick ligamentous cartilage that connects it to its fellow of the other side:—The process which goes down from that to the *os ischium* is broad and rough before, where the *gracilis* and upper heads of the *triceps*, or rather *quadriceps adductor femoris* have their origin.

The substance of the *os pubis* is the same as of other broad bones.

Only a part of the large end of this bone is ossified, and the whole leg is cartilaginous, in a child born at the full time.

Bewixt the *os ischium* and *pubis*, a very large irregular hole is left, which, from its resemblance to a door or shield, has been called *thyroïdes*. This hole is all, except the niche for the posterior crural nerve, filled up in a recent subject with a strong ligamentous membrane, that adheres very firmly to its circumference. From this membrane chiefly the two *obturator* muscles, external and internal, take their rise.—The great design of this hole, besides rendering the bone lighter, is to allow a strong enough origin to the *obturator* muscles, and sufficient space for lodging their bellies, that there may be no danger of disturbing the functions of the contained *viscera* of the *pelvis* by the actions of the internal, nor of the external being bruised by the thigh-bone, especially by its lesser *trochanter*, in the motions of the thigh inwards: Both which inconveniences must have happened, had the *osса innominata* been complete here, and of sufficient thickness and strength to serve as the fixed point of these muscles.—The bowels sometimes make their way through the niche for the vessels, at the upper part of this *thyroid* hole, and this causes a *bernia* in this place (c).

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In

(c) *Mémoires de l'acad. de chirurgie*, tom. I, p. 709, &c.

In the external surface of the *os innominata*, near the outside of the great hole, a large deep cavity is formed by all the three bones conjunctly: For the *os pubis* constitutes about one fifth; the *os ilium* makes something less than two-fifths, and the *os ischium* as much more than two-fifths. The brims of this cavity are very high, and are still much more enlarged by the ligamentous cartilage, with which they are tipped in a recent subject. From this form of the cavity it has been called *acetabulum*; and for a distinguishing character, the name of the bone that constitutes the largest share of it is added; therefore *acetabulum ossis ischii* (*d*) is the name this cavity commonly bears.—Round the base of the *supercilia* the bone is rough and unequal, where the *capsular* ligament of the articulation is fixed.—The brims at the upper and back-part of the *acetabulum* are much larger and higher than any where else; which is very necessary to prevent the head of the *femur* from slipping out of its cavity at this place, where the whole weight of the body bears upon it, and consequently would otherwise be constantly in danger of thrusting it out.—As these brims are extended downwards and forwards, they become less; and at their internal lower part a breach is made in them; from the one side of which to the other, a ligament is placed in the recent subject; under which a large hole is left, which contains a fatty cellular substance and vessels. The reason of which appearance has afforded matter of debate. To me it seems evidently contrived for allowing a larger motion to the thigh inwards: For if the bony brims had been here continued, the neck of the thigh-bone must have struck upon them when the thighs were brought across each other; which, in a large strong motion this way, would have endangered the neck of the one bone, or brim of the other. Then the vessels which are distributed to the joint may safely enter at the sinuosity in the bottom of the breach; which being however larger than is necessary

(*d*) *Coxæ, coxendicis.*

fary for that purpose, allows the large mucilaginous gland of the joint to escape below the ligament, when the head of the thigh-bone is in hazard of pressing too much upon it in the motions of the thigh outwards (e).—Besides this difference in the height of the brims, the *acetabulum* is otherwise unequal: For the lower internal part of it is depressed below the cartilaginous surface of the upper part, and is not covered with cartilage; into the upper part of this particular depression, where it is deepest, and of a semilunar form, the ligament of the thigh-bone, commonly, though improperly, called the *round* one, is inserted; while, in its more superficial lower part, the large mucilaginous gland of this joint is lodged. The largest share of this separate depression is formed in the *os ischium*.

From what has been said of the condition of the three bones composing this *acetabulum* in new-born children, it must be evident, that a considerable part of this cavity is cartilaginous in them.

The *ossa innominata* are joined at their back-part to each side of the *os sacrum* by a sort of suture, with a very thin intervening cartilage, which serves as so much glue to cement these bones together; and strong ligaments go from the circumference of this unequal surface, to connect them more firmly. The *ossa innominata* are connected together at their fore-part by the ligamentous cartilage interposed between the two *ossa pubis*.—These bones can therefore have no motion in a natural state, except what is common to the trunk of the body, or to the *os sacrum*. But it has been disputed, whether or not they loosen so much from each other, and from the *os sacrum*, in child-birth, by the flow of *mucus* to the *pelvis*, and by the throws of the labour, as that the *ossa pubis* recede from each other, and thereby allow the passage between the bones to be enlarged.—Several observations (f) shew that this relaxation sometimes happens:

O 2

But

(e) Petit. Mémoires de l'acad. des sciences, 1722.

(f) Bauhin. Theat. anat. lib. 1. cap. 49.—Spigel. Anat. lib. 2. cap. 24.—Riolan. Anthroprogr. lib. 6. cap. 12.—Diemerbroek Anat. lib. 9. cap. 16.

But those who had frequently opportunities of dissecting the bodies of women who died immediately after being delivered of children, teach us to beware of regarding this as the common effect of child-birth; for they found such a relaxation in very few of the bodies which they examined (*b*).

Considering what great weight is supported in our erect posture, by the articulation of the *os innominata* with the *os sacrum*, there is great reason to think that if the conglutinated surfaces of these bones were once separated, (without which, the *os pubis* cannot shuffle on each other), the ligaments would be violently stretched, if not torn; from whence many disorders would arise (*c*).

Each *os innominatum* affords a socket (the *acetabulum*) for the thigh-bones to move in, and the trunk of the body rolls here so much on the heads of the thigh-bones, as to allow the most conspicuous motions of the *trunk*, which are commonly thought to be performed by the bones of the spine.—This articulation is to be more fully described after the *os femoris* are examined.

The *pelvis* then has a large open above where it is continued with the *abdomen*, is strongly fenced by bones on the sides, back, and fore-part, and appears with a wide opening below, in the skeleton; but, in the recent subject, a considerable part of the opening is filled by the *sacro-sciatic ligaments*, *pyriform*, *internal obturator*, *levatores ani*, *gemini*, and *coccygei* muscles, which support and protect the contained parts better than bones could have done; so that space is only left at the lowest part of it, for the large excretaries, the *vesica urinaria*, *intestinum rectum*, and in females, the *uterus*, to discharge themselves.

The *THORAX* (*d*), or *chest*, which is the only part of the trunk of the body which we have not yet described,

(*b*) Hildan. Epist. cent. obs. 46.—Dionis Sixieme demonst. des os.—Morgagn. Advers. 3. animad. 15.

(*c*) Ludov. in Ephem. German. dec. 1. ann. 3. obs. 255.

(*d*) *Pectus*, *cassum*.

described, reaches from below the neck to the belly; and, by means of the bones that guard it, is formed into a large cavity: The figure of which is somewhat conoidal; but its upper smaller end is not finished, being left open for the passage of the wind-pipe, gullet, and large blood-vessels; and its lower part, or base, has no bones, and is shorter before than behind; so that, to carry on our comparison, it appears like an oblique section of the conoid. Besides which we ought also to remark, that the lower part of this cavity is narrower than some way above (e); and that the middle of its back-part is considerably diminished by the bones standing forwards into it.

The bones which form the *thorax*, are, the twelve dorsal *vertebrae* behind, the ribs on the sides, and the *sternum* before.

The *vertebrae* have already been described as part of the spine; and therefore are now to be passed.

The *RIBS*, or *cōcta* (f), (as if they were *custodes*, or guards, to these principal organs of the animal machine, the heart and lungs), are the long crooked bones placed at the side of the chest, in an oblique direction downwards in respect of the back-bone.—Their number is generally twelve on each side; though frequently eleven or thirteen have been found (g).—Sometimes the ribs are found pteraturally conjoined or divided (h).

The ribs are all concave internally; where they are also made smooth by the action of the contained parts, which, on this account, are in no danger of being hurt by them; and they are convex externally, that they might resist that part of the pressure of the atmosphere, which is not balanced by the air within the lungs, during *inspiration*.—The ends of the ribs next the *vertebrae* are rounder than they are after these bones have advanced forwards, when they become

(e) Albin. de ossib. sect. 169.

(f) Πλατύκη, τεπιστερυκη, σκαλα.

(g) Riolan. Comment. de ossibus, cap. 19.—Marchetti, cap. 9.—Cowper Explicat. tab. 93. and 94.—Morgagni. Advers. Anat.

(h) Sue Trad. d'osteolog. p. 141.

flatter and broader, and have an upper and lower edge, each of which is made rough by the action of the *intercostal* muscles, inserted into them. These muscles, being all of nearly equal force, and equally stretched in the interstices of the ribs, prevent the broken ends of these bones in a fracture from being removed far out of their natural place, to interrupt the motion of the vital organs.—The upper edge of the ribs is more obtuse and rounder than the lower, which is depressed on its internal side by a long *fossa*, for lodging the intercostal vessels and nerves; on each side of which there is a ridge, to which the intercostal muscles are fixed. The *fossa* is not observable however at either end of the ribs; for at the posterior or root, the vessels have not yet reached the ribs; and, at the fore-end, they are split away into branches, to serve the parts between the ribs: Which plainly teaches surgeons one reason of the greater safety of performing the operation of the *empyema* towards the sides of the *thorax*, than either near the back or the breast.

At the posterior end (*i*) of each *rib*, a little head is formed, which is divided by a middle ridge into two plain or hollow surfaces; the lowest of which is the broadest and deepest in most of them. The two planes are joined to the bodies of two different *vertebrae*, and the ridge forces itself into the intervening cartilage.—A little way from this head, we find, on the external surface, a small cavity, where mucilaginous glands are lodged; and round the head, the bone appears spongy, where the capsular ligament of the articulation is fixed.—Immediately beyond this a flattened tubercle rises, with a small cavity at, and roughness about its root, for the articulation of the rib with the transverse process of the lowest of the two *vertebrae*, with the bodies of which the head of the rib is joined.—Advancing farther on this external surface, we observe in most of the ribs another smaller tubercle, into which ligaments which connect the ribs

ribs to each other, and to the transverse processes of the *vertebrae* and portions of the *longissimus dorsi*, are inserted.—Beyond this the ribs are made flat by the *sacro-lumbalis* muscle, which is inserted into the part of this flat surface farthest from the spine, where each rib makes a considerable curve, called by some its angle.—Then the rib begins to turn broad, and continues so to its anterior end, (*k*), which is hollow and spongy, for the reception of, and firm coalition with the cartilage that runs thence to be inserted into the *sternum*, or to be joined with some other cartilage.—In adults, generally the cavity at this end of the ribs is smooth and polished on its surface; by which the articulation of the cartilage with it has the appearance of being designed for motion: but it has none.

The substance of the ribs is spongy, cellular, and only covered with a very thin external lamellated surface, which increases in thickness and strength as it approaches the *vertebrae*.

To the fore-end of each rib, a long broad and strong cartilage is fixed, and reaches thence to the *sternum*, or is joined to the cartilage of the next rib. This course, however, is not in a straight line with the rib; for, generally, the cartilages make a considerable curve, the concave part of which is upwards; therefore, at their insertion into the *sternum*, they make an obtuse angle above, and an acute one below.—These cartilages are of such a length as never to allow the ribs to come to a right angle with the spine; but they keep them situated so obliquely, as to make an angle very considerably obtuse above, till a force exceeding the elasticity of the cartilages is applied.—These cartilages, as all others, are firmer and harder internally, than they are on their external surface; and sometimes in old people, all their middle substance becomes bony, while a thin cartilaginous *lamella* appears externally (*a*). The ossification, however, begins frequently at the external surface.—

The

(*k*) Πλατη, palmula.

(*a*) Vesal. lib. 2. cap. 19.

The greatest alternate motions of the cartilages being made at their great curvature, that part remains frequently cartilaginous, after all the rest is ossified (b).

The ribs then are articulated at each end, of which the one behind is doubly joined to the *vertebrae*; for the head is received into the cavities of two bodies of the *vertebrae*, and the larger tubercle is received into the depression in the transverse process of the lower *vertebra*.—When one examines the double articulation, he must immediately see, that no other motion can here be allowed than upwards and downwards; since the transverse process hinders the rib to be thrust back; the resistance on the other side of the *sternum* prevents the rib's coming forward; and each of the two joints, with the other parts attached, oppose its turning round. But then it is likewise as evident, that even the motion upwards and downwards can be but small in any one rib at the articulation itself. But as the ribs advance forwards, the distance from their centre of motion increasing, the motion must be larger; and it would be very conspicuous at their anterior ends, were not they resisted there by the cartilages, which yield so little, that the principal motion is performed by the middle part of the ribs, which turns outwards and upwards, and occasions the twist remarkable in the long ribs at the place near their fore-end where they are most resisted (c).

Hitherto I have laid down the structure and connection which most of the ribs enjoy, as belonging to all of them; but must now consider the specialities wherein any of them differ from the general description given, or from each other.

In viewing the ribs from above downwards, their figure is still straighter; the uppermost being the most crooked of any.—Their obliquity, in respect of the spine, increases as they descend; so that though

their

(b) Havers Osteolog. nov. disc. 5. p. 289.

(c) Winflow Memoires de l'acad. des sciences, 1720.

their distances from each other is very little different at their back-part, yet at their fore-ends the distances between the lower ones must increase.—In consequence, too, of this increased obliquity of the lower ribs, each of their cartilages makes a greater curve in its progress from the rib towards the *sternum*; and the tubercles, that are articulated to the transverse processes of the *vertebrae*, have their smooth surfaces gradually facing more upwards.—The ribs becoming thus more oblique, while the *sternum* advances forwards in its descent, makes the distance between the *sternum* and the anterior end of the lower ribs greater than between the *sternum* and the ribs above; consequently the cartilages of those ribs that are joined to the breast-bone, are longer in the lower than in the higher ones.—These cartilages are placed nearer to each other as the ribs descend, which occasions the curvature of the cartilages to be greater.

The length of the ribs increases from the first and uppermost rib, as far down as the seventh; and from that to the twelfth, as gradually diminishes.—The superior of the two plain, or rather hollow surfaces, by which the ribs are articulated to the bodies of the *vertebrae*, gradually increases from the first to the fourth rib, and is diminished after that in each lower rib.—The distance of their angles from the heads always increases as they descend to the ninth, because of the greater breadth of the *sacro-lumbalis* muscle (*d*).

The ribs are commonly divided into *true* and *false*.

The *true* (*e*) *costæ* are the seven upper ones of each side, whose cartilages are all gradually longer as the ribs descend, and are joined to the breast-bone; so that being pressed constantly between two bones, they are flattened at both ends, and are thicker, harder, and more liable to ossify, than the other cartilages, that are not subject to so much pressure. These ribs include

(d) Winflow Exposition anatomique des os secx, § 643.

(e) *Tvngæ*, Germanæ, legitimæ.

include the heart and lungs; and therefore are the proper or true *custodes* of life.

The five inferior ribs of each side are the *false* or *BASTARD* (*f*), whose cartilages do not reach to the *sternum*; and therefore, wanting the resistance at their fore-part, they are there pointed; and, on this account, having less pressure, their substance is softer.—The cartilages of these *false ribs* are shorter as the ribs descend.—To all these five ribs the circular edge of the *diaphragm* is connected; and its fibres, instead of being stretched immediately transversely, and so running perpendicular to the ribs, are pressed so as to be often, especially in expiration, parallel to the plane in which the ribs lie: Nay, one may judge by the attachments which these fibres have so frequently to the sides of the *thorax*, a considerable way above where their extremities are inserted into the ribs, and by the situation of the *viscera*, always to be observed in a dead subject laid supine, that there is constantly a large concavity formed on each side by the *diaphragm* within these bastard ribs, in which the stomach, liver, spleen, &c. are contained; which, being only reckoned among the *viscera naturalia*, have occasioned the name of *bastard custodes* to these bones.

Hence, in simple fractures of the false ribs, without fever, the stomach ought to be kept moderately filled with food, lest the pendulous ribs falling inwards, should thereby increase the pain, cough, &c. (*g*).—Hence likewise we may learn how to judge better of the seat of several diseases, and to do the operation of the *empyema*, and some others, with more safety than we can do, if we follow the common directions.

The eight upper ribs were formerly (*b*) classed into pairs, with particular names to each two, to wit,

the

(*f*) Μαλακαις, χειροδεις, αχαρθαι, κτενες, ποσι, adulterinæ, spuriae, illegitimæ.

(*g*) Hippocrat. de articulo, § 51.—Pare, lib. 15. cap. II.

(*b*) Laurent. Hist. anat. lib. 2. cap. 29.—Paaw de ossibus, par. 3. cap. 2.

the crooked, the solid, the pectoral, the twisted: But these names are of so little use, that they are now generally neglected.

The first rib of each side is so situated, that the flat sides are above and below, while one edge is placed inwards, and the other outwards, or nearly so; therefore, sufficient space is left above it for the sub-clavian vessels and muscle; and the broad concave surface is opposed to the lungs: But then, in consequence of this situation, the channel for the intercostal vessels is not to be found, and the edges are differently formed from all the other, except the second; the lower one being rounded, and the other sharp.—The head of this rib is not divided into two plain surfaces by a middle ridge, because it is only articulated with the first *vertebra* of the *thorax*.—Its cartilage is ossified in adults, and is united to the *sternum* at right angles.—Frequently this first rib has a ridge rising near the middle of its posterior edge, where one of the heads of the *scalenus* muscle rises.—Farther forward it is flattened, or sometimes depressed by the clavicle.

The fifth, sixth, and seventh, or rather the sixth, seventh, eighth, and sometimes the fifth, sixth, seventh, eighth, ninth ribs, have their cartilages at least contiguous; and frequently they are joined to each other by cross cartilages; and most commonly the cartilages of the eighth, ninth, tenth, are connected to the former and to each other by firm ligaments.

The eleventh, and sometimes the tenth rib, has no tubercle for its articulation with the transverse processes of the *vertebra*, to which it is only loosely fixed by ligaments.—The fossa in its lower edge is not so deep as in the upper ribs, because the vessels run more towards the interstice between the ribs.—Its fore-end is smaller than its body, and its short small cartilage is but loosely connected to the cartilage of the rib above.

The

The *twelfth rib* is the shortest and straightest.—Its head is only articulated with the last *vertebra* of the *thorax*: therefore is not divided into two surfaces.—This rib is not joined to the transverse process of the *vertebra*, and therefore has no tubercle, being often pulled necessarily inwards by the diaphragm, which an articulation with the transverse process would not have allowed.—The *fossa* is not found at its under-edge, because the vessels run below it.—The fore-part of this rib is smaller than its middle, and has only a very small pointed cartilage fixed to it.—To its whole internal side the diaphragm is connected.

The motions and uses of the ribs shall be more particularly treated of, after the description of the *sternum*.

The heads and tubercles of the ribs of a new-born child have cartilages on them; part of which becomes afterwards thin epiphyses.—The bodies of the ribs encroach gradually after birth upon the cartilages; so that the latter are proportionally shorter, when compared to the ribs, in adults, than in children.

Here I cannot help remarking the wise providence of our Creator, in preserving us from perishing as soon as we come into the world. The end of the bones of the limbs remain in a cartilaginous state after birth, and are many years before they are entirely united to the main body of their several bones; whereas, the condyles of the occipital bone, and of the lower jaw, are true original processes, and ossified before birth, and the heads and tubercles of the ribs are nearly in the same condition; and therefore, the weight of the large head is firmly supported; the actions of sucking, swallowing, respiration, &c. which are indispensably necessary for us as soon as we come into the world, are performed without danger of separating the parts of the bones that are most pressed on in these motions: Whereas, had these processes of the head, jaw, and ribs, been epiphyses at birth, children must have been exposed

to

to danger of dying by such a separation; the immediate consequences of which would be, the compression of the beginning of the *spinal* marrow, or want of food, or a stop put to respiration.

The *STERNUM* (*i*), or *breast-bone*, is the broad flat bone, or pile of bones, at the fore-part of the *thorax*.—The number of bones which this should be divided into, has occasioned debates among anatomists, who have considered it in subjects of different ages.—In adults of a middle age, it is composed of three bones, which easily separate after the cartilages connecting them are destroyed. Frequently the two lower bones are found intimately united; and very often in old people, the *sternum* is a continued bony substance from one end to the other; though we still observe two, sometimes three transverse lines on its surface; which are marks of the former divisions.

When we consider the *sternum* as one bone, we find it broadest and thickest above, and becoming smaller as it descends. The internal surface of this bone is somewhat hollowed for enlarging the *thorax*; but the convexity on the external surface is not so conspicuous, because the sides are pressed outwards by the true ribs; the round heads of whose cartilages are received into seven smooth pits, formed in each side of the *sternum*, and are kept firm there by strong ligaments, which on the external surface have a particular radiated texture (*k*).—Frequently the cartilaginous fibres thrust themselves into the bony substance of the *sternum*, and are joined by a sort of suture.—The pits at the upper part of the *sternum* are at the greatest distance one from another, and, as they descend, are nearer; so that the two lowest are contiguous.

The substance of the breast-bone is cellular, with a very thin external plate, especially on its internal surface, where we may frequently observe a cartilaginous

P

inous

(*i*) Στρογγυλός, os pectoris, ensiforme, scutum cordis.

(*k*) Ruyisch. Catalog. rar. fig. 9.

nous crust spread over it (*l*). On both surfaces, however, a strong ligamentous membrane is closely braced; and the cells of this bone are so small, that a considerable quantity of osseous fibres must be employed in the composition of it: Whence, with the defence which the muscles give it, and the moveable support it has from the cartilages, it is sufficiently secured from being broken; for it is strong by its quantity of bone; its parts are kept together by ligaments; and it yields enough to elude considerably the violence offered (*m*).

So far may be said of this bone in general; but the three bones, of which, according to the common account, it is composed in adults, are each to be examined.

The first, all agree, is somewhat of the figure of a heart, as it is commonly painted; only it does not terminate in a sharp point.—This is the uppermost thickest part of the sternum.

The upper middle part of this first bone, where it is thickest, is hollowed, to make place for the *trachea arteria*; though this cavity (*n*) is principally formed by the bone being raised on each side of it, partly by the clavicles thrusting it inwards, and partly by the *sterno-mastoidei* muscles pulling it upwards.—On the outside of each tubercle, there is an oblong cavity, that, in viewing it transversely from before backwards, appears a little convex: Into these *glenæ*, the ends of the clavicles are received.—Immediately below these, the sides of this bone begin to turn thinner; and in each a superficial cavity or a rough surface is to be seen, where the first ribs are received or joined to the *sternum*.—In the side of the under end of this first bone, the half of the pit for the second rib on each side is formed.—The upper part of the surface behind is covered with a strong ligament, which

(*l*) Jac. Sylv. in Galen de ossibus, cap. 12.

(*m*) Senac. in Mémoires de l'acad. des sciences, 1724.

(*n*) Σπαγη, jugulum, furcula superior.

which secures the clavicles; and is afterwards to be more particularly taken notice of.

The second or middle division of this bone, is much longer, narrower, and thinner, than the first; but, excepting that it is a little narrower above than below, it is nearly equal all over in its dimensions of breadth or thickness.—In the sides of it are complete pits for the third, fourth, fifth, and sixth ribs, and an half of the pits for the second and seventh. The lines, which are marks of the former division of this bone, being extended from the middle of the pits of one side to the middle of the corresponding pits of the other side.—Near its middle an unossified part of the bone is sometimes found, which, freed of the ligamentous membrane or cartilage that fills it, is described as a hole; and in this place, for the most part, we may observe a transverse line, which has made authors divide this bone into two.—When the cartilage between this and the first bone is not ossified, a manifest motion of this upon the first may be observed in respiration, or in raising the sternum, by pulling the ribs upwards, or distending the lungs with air in a recent subject.

The third bone is much less than the other two, and has only one half of the pit for the seventh rib formed in it; wherefore it might be reckoned only an *appendix* of the sternum.—In young subjects it is always cartilaginous, and is better known by the name of *cartilago xiphoides* or *ensiformis* (o), than any other; though the ancients often called the whole sternum, *ensiforme*, comparing the two first bones to the handle, and this *appendix* to the blade of a sword.—This third bone is seldom of the same figure, magnitude, or situation in any two subjects; for sometimes it is a plain triangular bone, with one of the angles below, and perpendicular to the middle of the upper side, by which it is connected to the second bone.—

(o) *Clypealis, gladialis, mucronata, malum granatum, scutum stomachi, epiglottalis, cultralis, medium furcula interioris, sotifermis, ensiculata.*

In other people, the point is turned to one side, or obliquely forwards or backwards.—Frequently it is all nearly of an equal breadth, and in several subjects it is bifurcated; whence some writers give it the name of *furcella* or *furcula inferior*; or else it is unossified, in the middle.—In the greatest number of adults it is ossified, and tipped with a cartilage; in some, one half of it is cartilaginous, and in others, it is all in a cartilaginous state.—Generally, several oblique ligaments fixed at one end to the cartilages of the ribs, and by the other to the outer surface of the *xiphoid* bone, connect it firmly to those cartilages (*p*).

So many different ways this small bone may be formed, without any inconvenience: But then some of these positions may be so directed, as to bring on a great train of ill consequences; particularly, when the lower end is ossified, and is too much turned outwards or inwards (*q*), or when the conjunction of this *appendix* with the second bone is too weak (*r*).

The *sternum* is joined by cartilages to the seven upper ribs, unless when the first coalesces with it in an intimate union of substance: And its unequal cavity on each side of its upper end is fitted for the ends of the clavicles.

The *sternum* most frequently has four round small bones, surrounded with cartilage, in children born at the full time; the uppermost of these, which is the first bone, being the largest.—Two or three other very small bony points are likewise to be seen in several children.—The number of bones increases for some years, and then diminishes, but uncertainly, till they are at last united into those above described of an adult.

The

(*p*) Weitbrecht, *Syndesmolog.* p. 121.

(*q*) Rolfinck. *Dissert. anat.* lib. 2. cap. 41.—Paaw de ossib. par. I. cap. 3. & par. 3. cap. 3.—Codronchi de prolapsu cartilagin. mucronat.

(*r*) Paaw, *ibid.*—Borrich. *aet. Hafn.* vol. 5. ob. 79.—Bonet. *Sculpchret. anat.* tom. 2. lib. 3. § 5. Append. ad obs. 8. et. *ibid.* § 7. obs. 19.

The uses of this bone are, to afford origin and insertion to several muscles; to sustain the *mediastinum*, to defend the vital organs, the heart and lungs, at the fore-part; and, lastly, by serving as a moveable *fulcrum* of the ribs, to assist considerably in respiration: Which action, so far as it depends on the motion of the bones, we are now at liberty to explain.

When the ribs that are connected by their cartilages to the *sternum*, or to the cartilages of the true ribs, are acted upon by the intercostal muscles, they must all be pulled from the oblique position which their cartilages kept them in, nearer to right angles with the *vertebrae* and *sternum*, because the first or uppermost rib is by much the most fixed of any; and the cartilages making a great resistance to raising the anterior ends of the ribs, their large arched middle parts turn outwards as well as upwards.—The *sternum*, pressed strongly on both sides by the cartilages of the ribs, is pushed forwards, and that at its several parts, in proportion to the length and motion of its supporters, the ribs; that is, most at its lower end.—The *sternum* and the cartilages, thus raised forwards, must draw the *diaphragm* connected to them; consequently so far stretch it, and bring it nearer to a plane.—The power that raises this bone and the cartilages, fixes them sufficiently to make them resist the action of the *diaphragm*, whose fibres contract at the same time, and thrust the *viscera* of the *abdomen* downwards.—The arched part of the ribs being thus moved outwards, their anterior ends and the *sternum* being advanced forwards, and the *diaphragm* being brought nearer to a plain surface, instead of being greatly convex on each side within each cavity of the *thorax*, it is evident how considerably the cavity, of which the nine or ten upper ribs are the sides, must be widened, and made deeper and longer.—While this is doing in the upper ribs, the lower ones, whose cartilages are not joined to the *sternum* or to other cartilages, move very differently, though they conspire to the same intention, the enlargement of the

thorax: For having no fixed point to which their anterior ends are fastened, and the *diaphragm* being inserted into them at the place where it runs pretty straight upwards from its origin at the *vertebrae*, these ribs are drawn downwards by this strong muscle, and by the muscles of the *abdomen*, which, at this time, are resisting the stretching force of the bowels; while the intercostal muscles are pulling them in the contrary direction, to wit, upwards: The effect therefore of either of these powers, which are antagonists to each other, is very little, as to moving the ribs either up or down; but the muscles of the *abdomen*, pushed at this time outwards by the *viscera*, carry these ribs along with them.—Thus the *thorax* is not only not allowed to be shortened, but is really widened at its lower part, to assist in making sufficient space for the due distension of the lungs.

As soon as the action of these several muscles ceases, the elastic cartilages, extending themselves to their natural situation, depress the upper ribs, and the *sternum* subsides;—the diaphragm is thrust up by the *viscera abdominalia*, and the oblique and transverse muscles of the belly serve to draw the inferior ribs inwards at the same time.—By these causes, the cavity of the breast is diminished in all its dimensions.

Though the motions above described of the ribs and *sternum*, especially of the latter bone, are so small in the mild respiration of a healthy person, that we can scarce observe them; yet they are manifest whenever we designedly increase our respiration, or are obliged to do it after exercise, and in several diseases.

OF THE SUPERIOR EXTREMITIES.

Authors are much divided in their opinions about the number of bones which each *superior extremity* (*a*) should be said to consist of, some describing the

(*a*) Κωλα, γυα, ιχναδες, Enata, adnata, explantata membra, artus.

the *clavicle* and *scapula* as part of it, others classing these two bones with those of the *thorax*: But since most quadrupeds have no *clavicles*, and the human *thorax* can perform its functions right when the *scapula* is taken away (*b*), whereas it is impossible for us to have the right use of our arms without these bones; I must think that they belong to the *superior extremities*; and therefore shall divide each of them into the *shoulder, arm, fore-arm, and hand.*

The *SHOULDER* consists of the *clavicle* and *scapula*.

CLAVICULA, or *collar-bone* (*c*), is the long crooked bone, in figure like an *Italic s*, placed almost horizontally between the upper lateral part of the *sternum*, and what is commonly called the top of the shoulder, which, as a *clavis* or beam, it bears off from the trunk of the body.

The *clavicle*, as well as other long round bones, is larger at its two ends, than in the middle. The end next to the *sternum* (*d*) is triangular: The angle behind is considerably produced, to form a sharp ridge, to which the transverse ligament, extended from one clavicle to the other, is fixed (*e*).—The side opposite to this is somewhat rounded.—The middle of this protuberant end is as irregularly hollowed, as the cavity in the *sternum* for receiving it is raised; but in a recent subject, the irregular concavities of both are supplied by a moveable cartilage, which is not only much more closely connected every where by ligaments to the circumference of the articulation, than those of the lower jaw are; but it grows to the two bones at both its internal and external end; its substance at the internal end being soft, but very strong, and resembling the intervertebral cartilages (*f*).

From

(*b*) *Philosop. transact. numb. 449. § 5.*

(*c*) *Os jugulare, jugulum, furcula, ligula, clavis, humerus qui-
busdam.*

(*d*) *Παραφραγίς.*

(*e*) *Riolan. Encheirid. anat. lib. 6. cap. 13.—Winflow, expos.
anat. des os frais, § 248.—Weitbrecht, Act. Petropolit. tom. 4. p.
255. et Syndesmolog. sect. 2. I. § 3.*

(*f*) *Weitbrecht, Syndesmolog. sect. 2. I. sect 6.*

From this internal end, the *clavicle*, for about two fifths of its length, is bended obliquely forwards and downwards. On the upper and fore-part of this curvature a small ridge is seen, with a plain rough surface before it; whence the *musculus sternohyoideus* and *sterno-mastoideus* have in part their origin.—Near the lower angle a small plain surface is often to be remarked, where the first rib and this bone are contiguous (*g*), and are connected by a firm ligament (*b*).—From this a rough plain surface is extended outwards, where the pectoral muscle has part of its origin.—Behind, the bone is made flat and rough by the insertion of the larger share of the subclavian muscle.—After the clavicle begins to be bended backwards, it is round, but soon after becomes broad and thin; which shape it retains to its external end.—Along the external concavity, a rough sinuosity runs, from which some part of the deltoid muscle takes its rise:—Opposite to this, on the convex edge, a scabrous ridge gives insertion to a share of the *cucullaris* muscle. The upper surface of the clavicle here is flat; but the lower is hollow, for lodging the beginning of the *musculus subclavius*; and towards its back-part a tubercle rises, to which, and a roughness near it, the strong short thick ligament connecting this bone to the *coracoid process* of the *scapula* is fixed.

The external end (*i*) of this bone is horizontally oblong, smooth, sloping at the posterior side, and tipped in a recent subject with a cartilage, for its articulation with the *acromion scapule*.—Round this the bone is spongy, for the firmer connection of the ligaments.

The medullary arteries, having their direction obliquely outwards, enter the clavicles by one or more small passages in the middle of their back-part.

The substance of this bone is the same as of the other round long bones.

The

(*g*) Dionis, Sixieme demonst. des os.

(*b*) Weitbrecht, Syndesmolog. sect. 2. L. §. 7.

(*i*) Επωμίς.

The triangular unequal interior end of each *clavicle*, has the cartilage above described interposed betwixt it and the irregular cavity of the *sternum*.—The ligaments, which surround this articulation to secure it, are so short and strong, that little motion can be allowed any way; and the strong ligament that is stretched across the upper *furcula* of the *sternum*, from the posterior prominent angle of the one clavicle, to the same place of the other clavicle, serves to keep each of these bones more firmly in their place.—By the assistance, however, of the moveable intervening cartilage, the clavicle can, at this joint, be raised or depressed, and moved backwards and forwards so much, as that the external end, which is at a great distance from that axis, enjoys very conspicuous motions.—The articulation of the exterior end of the clavicle shall be considered after the description of the *scapula*.

The clavicles of infants are not deficient in any of their parts; nor have they any epiphyses at their extremities joined afterwards to their bodies, as most other such long bones have, which preserves them from being bended too much, and from the danger of any unossified parts being separated by the force which pulls the arms forwards.

The uses of the clavicles are, to keep the *scapulae*, and consequently all the *superior extremities*, from falling in and forward upon the *thorax*; by which, as in most quadrupeds, the motions of the arms would be much confined, and the breast made too narrow.—The clavicles likewise afford origin to several muscles, and a defence to large vessels.

From the situation, figure, and use of the clavicles, it is evident, that they are much exposed to fractures; that their broken parts must generally go by each other; and that they are difficultly kept in their place afterwards.

SCAPULA, or *shoulder-blade (b)*, is the triangular bone

(b) οὐοπλάκας, επινωτίον, latitudo humeri, sceptulum vel scutulum opertum, spatula, ala, humerus, clypeus, scutum thoracis.

bone situated on the outside of the ribs, with its longest side called its *base*, towards the spinal processes of the *vertebrae*, and with the angle at the upper part of this side about three inches, and the lower angle at a greater distance from these processess.—The back-part of the *scapula* has nothing but the thin ends of the *serratus anticus major* and *subscapularis* muscles between it and the ribs: But as this bone advances forwards, its distance from the ribs increases.—The upper or shortest side, called the *superior costa* of the *scapula* is nearly horizontal, and parallel with the second rib.—The lower side, which is named the *inferior costa*, is extended obliquely from the third to the eighth rib.—The situation of this bone here described, is when people are sitting or standing in a state of inactivity, and allowing the members to remain in the most natural easy posture.—The inferior angle of the *scapula* is very acute; the upper one is near to a right angle; and what is called the anterior, does not deserve the name, for the two sides do not meet to form an angle.—The body of this bone is concave towards the ribs, and convex behind, where it has the name of *dorsum* (*c*).—Three processess are generally reckoned to proceed from the *scapula*.—The first is the large spine that rises from its convex surface behind, and divides it unequally.—The second process stands out from the fore-part of the upper side; and, from its imaginary resemblance to a crow's beak, is named *coracoides* (*d*).—The third process is the whole thick bulbous fore-part of the bone.

After thus naming the several constituent parts of the *scapula*, the particular description will be more easily understood.

The *base*, which is tipped with cartilage in a young subject, is not all straight: For above the spine, it runs obliquely forwards to the superior angle; that here it might not be too protuberant backwards, and so bruise the muscles and teguments: Into the oblique.

(c) *Xiphion.*

(d) *Anchoroides, sigmoides, digitalis, ancistroides.*

lique space the *musculus patientia* is inserted.—At the root of the spine, on the back-part of the base, a triangular plain surface is formed, by the pressure of the lower fibres of the *trapezius*.—Below this the edge of the *scapula* is scabrous and rough, for the insertion of the *serratus major anticus* and *rhomboid* muscles.

The back-part of the inferior angle is made smooth by the *latissimus dorsi* passing over it. This muscle also alters the direction of the *inferior costa* some way forwards from this angle: and so far it is flattened behind by the origin of the *teres major*.—As the *inferior costa* advances forward, it is of considerable thickness, is slightly hollowed and made smooth behind by the *teres minor*, while it has a *fossa* formed into it below by part of the *subscapularis*; and between the two a ridge with a small depression appears, where the *longus extensor cubiti* has its origin.

The *superior costa* is very thin; and near its fore-part there is a semilunar niche, from one end of which to the other a ligament is stretched; and sometimes the bone is continued, to form one, or sometimes two holes for the passage of the scapular blood-vessels and nerves.—Immediately behind this semilunar cavity the *coraco-hyoid* muscle has its rise.—From the niche to the termination of the *fossa* for the *teres minor*, the *scapula* is narrower than any where else, and supports the third process. This part has the name of *cervix*.

The whole *dorsum* of the *scapula* is always said to be convex; but, by reason of the raised edges that surround it, it is divided into two cavities by the spine, which is stretched from behind forwards, much nearer to the superior than to the *inferior costa*.—The cavity above the spine is really concave where the *supra-spinatus* muscle is lodged; while the surface of this bone below the spine, on which the *infra-spinatus* muscle is placed, is convex, except a *fossa* that runs at the side of the *inferior costa*.

The internal or anterior surface of this bone is hollow, except in the part above the spine, which is convex.—

convex.—The *subscapularis* muscle is extended over this surface, where it forms several ridges and intermediate depressions, commonly mistaken for prints of the ribs; they point out the interstices of the bundles of fibres of which the *subscapularis* muscle is composed (*e*).

The spine (*f*) rises small at the base of the *scapula*, and becomes higher and broader as it advances forwards.—On the sides it is unequally hollowed and crooked, by the actions of the adjacent muscles.—Its ridge (*g*) is divided into two rough flat surfaces: Into the upper one, the *trapezius* muscle is inserted; and the lower one has part of the *deltoid* fixed to it.—The end of the spine, called *acromion* (*h*), or top of the shoulder, is broad and flat, and is sometimes only joined to the spine by a cartilage (*i*).—The anterior edge of the *acromion* is flat, smooth, and covered with a cartilage, for its articulation with the external end of the *clavicle*; and it is hollowed below, to allow a passage to the *infra* and *supra spinati* muscles, and free motion to the *os humeri*.

The *coracoid* (*k*) process is crooked, with its point inclining forwards; so that a hollow is left at the lower side of its root, for the passage of the *infra-scapularis* muscle.—The end of this process is marked with three plain surfaces. Into the internal, the *serratus minor anticus* is inserted: From the external, one head of the *biceps flexor cubiti* rises; and from the lower one, the *coraco-brachialis* has its origin.—At the upper part of the root of this process, immediately before the *semilunar* cavity, a smooth tubercle appears, where a ligament from the *clavicle* is fixed. From all the external side of this coracoid *apophysis*, a broad ligament goes out, which becomes narrower where it

(*e*) Winslow, in Memoires de l'acad. des sciences, 1722.

(*f*) Ραχις, ὑπεροχη ωμοστλατων, eminentia scapularum.

(*g*) Pterigium, crista.

(*h*) Επωμις αγκυροειδης, κορακοειδης, κατακλιτης, acromii os, summus armus, rostrum porcinum, processus digitalis.

(*i*) Sue Trad. d'Osteol. p. 160.

(*k*) Αγκυροειδης, σιγμοειδης, rostriformis.

it is fixed to the *acromion*.—The sharp pain, violent inflammation, and tedious cure of contusions in this part, are probably owing to these tendons and ligaments being hurt.

From the *cervix scapulae* the third process is produced. The fore-part of this is formed into a *glenoid cavity* (*l*), which is of the shape of the longitudinal section of an egg, being broad below, and narrow above.—Between the brims of this hollow and the fore-part of the root of the spine, a large sinuosity is left for the transmission of the *supra* and *infra-spinati* muscles; and on the upper-part of these brims we may remark a smooth surface, where the second head of the *biceps flexor cubiti* has its origin.—The root of the *supercilia* is rough all round, for the firmer adhesion of the capsular ligament of the articulation, and of the cartilage which is placed on these brims, where it is thick, but becomes very thin as it is continued towards the middle of the cavity, which it lines all over.

The medullary vessels enter the *scapula* near the base of the spine.

The substance of the *scapula*, as in all other broad flat bones, is cellular, but of an unequal thickness; for the neck and third process are thick and strong. The inferior *costa*, spine, and coracoid process, are of a middle thickness; and the body is so pressed by the muscles, as to become thin and diaphanous.

The *scapula* and clavicle are joined by plain surfaces, tipped with cartilage (*m*): by which neither bone is allowed any considerable motion, being tightly tied down by the common capsular ligament, and by a very strong one which proceeds from the coracoid process; but divides into two before it is fixed into the *clavicle*, with such a direction, as either can allow this bone to have a small rotation, in which its posterior edge turns more backwards, while the anterior one rises farther forwards; or it can yield to

Q

the

(*l*) Ωμοχετυλίς.

(*m*) *Acromion*, κατακλεῖς, clasfuræ.

the fore-part of the *scapula* moving downwards, while the back-part of it is drawn upwards; in both which cases, the oblong smooth articulated surfaces of the *clavicle* and *scapula* are not in the same plane, but stand a little transversely, or across each other, and thereby preserve this joint from luxations, to which it would be subject, if either of the bones was to move on the other perpendicularly up and down, without any rotation.—Sometimes a moveable ligamentous cartilage is found in this joint; otherwhiles, such a cartilage is only interposed at the anterior half of it; and in some old subjects I have found a sesamoid bone here (n).—The *scapula* is connected to the head, os *hyoides*, *vertebrae*, ribs, and arm-bone, by muscles, that have one end fastened to these bones, and the other to the *scapula*, which can move it upwards, downwards, backwards, or forwards; by the quick succession of these motions, its whole body is carried in a circle. But being also often moved as upon an axis perpendicular to its plane, its circumference turns in a circle whose centre this axis is (o). Whichever of these motions it performs, it always carries the outer end of the *clavicle* and the arm along with it.—The *glenoid cavity* of this bone receives the os *humeri*, which plays in it as a ball in a socket, as will be explained more hereafter.

The use of the *scapula* is, to serve as a *fulcrum* to the arm; and, by altering its position on different occasions, to allow always the head of the os *humeri* a right situated socket to move in; and thereby to assist and to enlarge greatly the motions of the *superior extremity*, and to afford the muscles which rise from it more advantageous actions, by altering their directions to the bone which they are to move.—This bone also serves to defend the back-part of the *thorax*, and is often employed to sustain weights, or to resist forces, too great for the arm to bear.

The

(n) Jac. Sylv. Ifagog. anat. lib. 1. cap. 2.

(o) See Winslow Memoires de l'acad. des sciences, 1726.

The base, *acromion*, coracoid process, and head of the *scapula*, are all in a cartilaginous state at birth; and the three first are joined as *epiphyses*; while the head, with the *glenoid cavity*, is not formed into a distinct separate bone, but is gradually produced by the ossification of the body of this bone being continued forwards.

The *ARM* has only one bone, best known by the Latin name of *os humeri* (*p*); which is long, round, and nearly straight.

The upper end of this bone (*q*) is formed into a large round smooth head, whose middle point is not in a straight line with the axis of the bone, but stands obliquely backwards from it.—The extent of the head is distinguished by a circular *fossa* surrounding its base, where the head is united to the bone, and the capsular ligament of the joint is fixed.—Below the fore-part of its base two tubercles stand out: The smallest one, which is situated most to the inside, has the tendon of the *subscapularis* muscle inserted into it.—The larger more external protuberance is divided, at its upper part, into three smooth plain surfaces; into the anterior of which the *musculus supra-spinatus*; into the middle or largest, the *infra-spinatus*; into the one behind, the *teres minor* is inserted.—Between these two tubercles, exactly in the fore-part of the bone, a deep long *fossa* is formed, for lodging the tendinous head of the *biceps flexor cubiti*; which, after passing, in a manner peculiar to itself, through the cavity of the articulation, is tied down by a tendinous sheath extended across the *fossa*; in which, and in the neighbouring tubercles, are several remarkable holes, which are penetrated by the tendinous and ligamentous fibres, and by vessels.—On each side of this *fossa*, as it descends in the *os humeri*, a rough ridge, gently flattened in the middle, runs from the roots of the tubercles.—The tendon of the *pectoral*

Q 2

muscle

(*p*) Ακρολίχ, αλεύν, *os brachii*, *armi*, *adjutorium*, *parvum brachium*, *canna brachii*.

(*q*) *Acroclium*.

muscle is fixed into the anterior of these ridges, and the *latissimus dorsi*, and *teres major*, are inserted into the internal one.—A little behind the lower end of this last, another rough ridge may be observed, where the *coraco-brachialis* is inserted.—From the back-part of the root of the largest tubercle a ridge also is continued, from which the *brevis extensor cubiti* rises.—This bone is flattened on the inside, about its middle, by the belly of the *biceps flexor cubiti*.—In the middle of this plain surface, the entry of the medullary artery is seen slanting obliquely downwards.—At the fore-side of this plane the bone rises in a sort of ridge, which is rough, and often has a great many small holes in it, where the tendon of the strong *deltoid* muscle is inserted; on each side of which the bone is smooth and flat, where the *brachioradialis intermus* rises. The exterior of these two flat surfaces is the largest; behind it a superficial spiral channel, formed by the *muscular* nerve, and the vessels that accompany it, runs from behind forwards and downwards.—The body of the *os humeri* is flattened behind by the extensors of the fore-arm.—Near the lower end of this bone, a large sharp ridge is extended on its outside, from which the *musculus spinator radii longus*, and the longest head of the *extensor carpi radialis* rise.—Opposite to this, there is another small ridge to which the *aponeurotic* tendon, that gives origin to the fibres of the internal and external *brachioradialis* muscles is fixed; and from a little depression on the fore-side of it, the *pronator radii teres* rises.

The body of the *os humeri* becomes gradually broader towards the lower end, where it has several processes; at the roots of which there is a cavity before, and another behind (r). The anterior is divided by a ridge into two; the external, which is the least, receives the end of the *radius*; and the internal receives the *coronoid process* of the *ulna* in the flexions of the fore-arm, while the posterior deep triangular cavity lodges the *olecranon* in the extensions of that member.

(r) *Radius*.

member.—The bone betwixt these two cavities is pressed so thin by the processes of the *ulna*, as to appear diaphanous in several subjects.—The sides of the posterior cavity are stretched out into two processes, one on each side: These are called *condyles*; from each of which a strong ligament goes out to the bones of the *fore-arm*.—The external *condyle*, which has an oblique direction also forwards in respect of the internal, when the arm is in the most natural posture (s), is equally broad, and has an obtuse smooth head rising from it forwards.—From the rough part of the *condyle*, the inferior head of the *bicornis*, the *extensor digitorum communis*, *extensor carpi ulnaris*, *anconaeus*, and some part of the *supinator radii brevis* take their rise; and on the smooth head the upper end of the *radius* plays.—Immediately on the outside of this, there is a sinuosity made by the shorter head of the *bicornis* muscle, upon which the muscular nerve is placed.—The internal *condyle* is more pointed and protuberant than the external; to give origin to some part of the *flexor carpi radialis*, *pronator radii teres*, *palmaris longus*, *flexor digitorum sublimis*, and *flexor carpi ulnaris*. Between the two *condyles*, is the *trochlea* or *pully*, which consists of two lateral protuberances, and a middle cavity, that are smooth and covered with cartilage.—When the *fore-arm* is extended, the tendon of the internal *brachiceus* muscle is lodged in the fore-part of the cavity of this *pully*.—The external protuberance, which is less than the other, has a sharp edge behind; but forwards, this edge is obtuse, and only separated from the little head, already described, by a small *fossa*, in which the joined edges of the *ulna* and *radius* move.—The internal protuberance of the *pully* is largest and highest; and therefore in the motions of the *ulna* upon it, that bone would be inclined outwards, was it not supported by the *radius* on that side.—Between this internal protuberance and *condyle*,

Q. 3. a sinuosity.

(s) Winiflow Memoires de l'acad. des sciences, 1732..

a sinuosity may be remarked, where the *ulnar* nerve passes.

The substance and the internal structure of the *os humeri* is the same, and disposed in the same way, as in other long bones.

The round head at the upper end of this bone is articulated with the *glenoid* cavity of the *scapula*; which being superficial, and having long ligaments, allows the arm a free and extensive motion.—These ligaments are however considerably strong. For, besides the common capsular one, the tendons of the muscles perform the office, and have been described under the name of *ligaments*.—Then the *acromion* and *coracoid* process, with the strong broad ligaments stretched betwixt them, secure the articulation above, where the greatest and most frequent force is applied to thrust the head of the bone out of its place. It is true that there is not near so strong a defence at the lower part of the articulation; but in the ordinary postures of the arm, that is, so long as it is at an acute angle with the trunk of the body, there cannot be any force applied at this place to occasion a luxation, since the joint is protected so well above.

The motions which the arm enjoys by this articulation, are to every side; and by the succession of these different motions, a circle may be described.—Besides which, the bone performs a small rotation round its own *axis*. But though this can be performed with the round head in all positions; yet as these vary, the effects upon the body of the bone are very different: For, if the middle of the head is the centre of rotation, as it is when the arm hangs down by the side, the body of the bone is only moved forwards and backwards; because the *axis* of motion of the head is nearly at right angles with the length of the bone (*t*); whereas, when the arm is raised to right angles with the trunk of the body, the centre of motion, and the axis of the bone, come to be in the same straight line; and therefore the body of the

(*t*) Hippocrat. de articul. § 1.

os humeri performs the same motion with its head.—Though the motions of the arm seem to be very extensive, yet the larger share of them depends on the motion of the *scapula*.—The lower end of the *os humeri* is articulated with the bones of the fore-arm, and carries them with it in all its motions, but serves as a base on which they perform the motions peculiar to themselves; as shall be described afterwards.

Both the ends of this bone are cartilaginous in a new-born infant, and the large head with the two tubercles, and the *trochlea* with the two *condyles*, become *epiphyses* before they are united to the body of the bone.

The *FORE-ARM* (*u*) consists of two long bones, the *ulna* and *radius*; whose situation, in respect of each other, is oblique in the least straining or most natural posture; that is, the *ulna* is not directly behind, nor on the outside of the *radius*, but in a middle situation between these two, and the *radius* crosses it.—The situation however of these two bones, and of all the other bones of the *superior extremity* that are not yet described, is frequently altered; and therefore, to shun repetitions, I desire it may be now remarked, that, in the remaining account of the *superior extremity*, I understand by the term of *posterior*, that part which is in the same direction with the back of the hand; by *anterior*, that answering to the palm; by *internal*, that on the same side with the thumb; by *external*, the side nearest to the little finger; supposing the hand always to be in a middle position between *pronation* and *supination*.

ULNA (*a*), so named from its being used as a measure, is the longest of the two bones of the fore-arm, and situated on the outside of the *radius*.

At the upper end of the *ulna* are two processes.—The posterior is the largest, and formed like a hook, whose concave surface moves upon the pully of the

as

(*u*) *Cubitus*, πηχυς, ωλεψη, πυγων, *ulna*, *lacertus*.

(*a*) *Cubitus*, πηχυς, προπηχυον, *socile majus*, *canna vel arundo major*, et *inferior brachii*.

os humeri, and is called *olecranon* (*b*), or top of the cubit.—The convex back-part of it is rough and scabrous, where the *longus*, *brevis*, and *brachiceus externus*, are inserted. The *olecranon* makes it unnecessary that the tendons of the extensor muscles should pass over the end of the *os humeri*; which would have been of ill consequence in the great flections of this joint, or when any considerable external force is applied to this part (*c*).—The anterior process is not so large, nor does it reach so high as the one behind; but is sharper at its end, and therefore is named *coronoid*.—Between these two processes, a large semicircular or *sigmoid* concavity is left; the surface of which, on each side of a middle rising, is sloping, and exactly adapted to the pulley of the bone of the arm.—Across the middle of it, there is a small sinuosity for lodging mucilaginous glands; where, as well as in a small hollow on the internal side of it, the cartilage that lines the rest of its surface is wanting.—Round the brims of this concavity the bone is rough, where the capsular ligament of the joint is implanted.—Immediately below the *olecranon*, on the back-part of the *ulna*, a flat triangular spongy surface appears, on which we commonly lean.—At the internal side of this, there is a larger hollow surface, where the *musculus anconeus* is lodged; and the ridge at the inside of this gives rise to the *musculus supinator radii brevis*.—Between the top of the ridge and the *coronoid* process is the semilunate smooth cavity, lined with cartilage, in which, and a ligament extended from the one to the other end of this cavity, the round head of the *radius* plays.—Immediately below it a rough hollow gives lodging to mucilaginous glands.—Below the root of the *coronoid* process, this bone is scabrous and unequal, where the *brachiceus internus* is inserted.—On the outside of that we observe a smooth concavity, where the beginning of the *flexor digitorum profundus* sprouts out.

The

(b) *Ayxæv*, gibber cubitus, additamentum necatum.

(c) Winslow Exposition anatomique du corps humain, traité des os, sect. 979.

The body of the *ulna* is triangular.—The internal angle is very sharp where the ligament that connects the two bones is fixed:—The sides, which make this angle, are flat and rough, by the action and adhesion of the many muscles which are situated here.—At the distance of one third of the length of the *ulna* from the top, in its fore-part, the passage of the medullary vessels is to be remarked slanting upwards.—The external side of this bone is smooth, somewhat convex, and the angles at each edge of it are blunted by the pressure of the muscles equally disposed about them.

As this bone descends, it becomes gradually smaller; so that its lower end terminates in a little head, standing on a small neck.—Towards the fore but outer part of which last, an oblique ridge runs, that gives rise to the *pronator radii quadratus*.—The head is round, smooth, and covered with a cartilage on its internal side, to be received into the semilunar cavity of the *radius*; while a *styloid process* (*d*) rises from its outside, to which is fixed a strong ligament that is extended to the *os cuneiforme* and *pisiforme* of the wrist.—Between the back-part of that internal smooth side and this process, a sinuosity is left for the tendon of the *extensor carpi ulnaris*.—On the fore-part of the root of the process, such another depression may be remarked for the passage of the *ulnar* artery and nerves.—The end of the bone is smooth, and covered with a cartilage.—Between it and the bones of the wrist, a doubly concave moveable cartilage is interposed; which is a continuation of the cartilage that covers the lower end of the *radius*, and is connected loosely to the root of the *styloid process*, and to the rough cavity there; in which mucilaginous glands are lodged.

The *ulna* is articulated above with the lower end of the *os humeri*, where these bones have depressions and protuberances corresponding to each other, so as to allow an easy and secure extension of the fore-arm to almost

(*c*) Γραφοειδη, malleolus externus.

almost a straight line with the arm, and flection to a very acute angle; but, by the slanting position of the pully, the lower part of the fore-arm is turned outwards in the extension, and inwards in the flection (*e*); and a very small kind of rotation is likewise allowed in all positions, especially when the ligaments are most relaxed by the fore-arm being in a middle degree of flection.—The *ulna* is also articulated with the *radius* and *carpus*, in a manner to be related afterwards.

RADIUS (*f*), so called from its imagined resemblance to a spoke of a wheel, or to a weaver's beam, is the bone placed at the inside of the fore-arm. Its upper end is formed into a circular little head, which is hollowed for an articulation with the tubercle at the side of the pully of the *os humeri*; and the half of the round circumference of the head next to the *ulna* is smooth, and covered with a cartilage, in order to be received into the semilunated cavity of that bone.—Below the head, the *radius* is much smaller; therefore this part is named its *cervix*, which is made round by the action of the *supinator radii brevis*.—At the external root of this neck, a tuberous process rises; into the outer part of which the *biceps flexor cubiti* is inserted.—From this a ridge runs downwards and inwards, where the *supinator radii brevis* is inserted; and a little below, and behind this ridge, there is a rough scabrous surface, where the *pronator radii teres* is fixed.

The body of the *radius* is not straight, but convex on its internal and posterior surfaces; where it is also made round by the equal pressure of the circumjacent muscles, particularly of the *extensors* of the thumb; but the surfaces next to the *ulna* are flattened and rough, for the origin of the muscles of the hand; and both terminate in a common sharp spine, to which the strong ligament extended betwixt the two bones of the fore-arm is fixed.—A little below the beginning

of

(*e*) Winflow, Mémoires de l'acad. des sciences, 1722.

(*f*) Κερχις, παραπτυχιον, facile minus, camna minor, arundo minor.

of the plain surface, on its fore-part, where the *flexor* muscle of the last joint of the thumb takes its origin; the passage of the medullary vessels is seen slanting upwards.—The *radius* becomes broader and flatter towards the lower end, especially on its fore-part, where its *pronator quadratus* muscle is situated.

The lower end of the *radius* is larger than the superior; though not in such a disproportion as the upper end of the *ulna* is larger than its lower end.—Its back-part has a flat strong ridge in the middle, and *fossa* on each side.—In a small groove immediately on the outside of the ridge, the tendon of the *extensor tertii internodii pollicis* plays.—In a large one beyond this, the tendons of the *indicator* and of the common *extensor* muscles of the fingers pass.—Contiguous to the *ulna*, there is a small depression made by the *extensor minimi digiti*.—On the inside of the ridge there is a broad depression, which seems again subdivided, where the two tendons of the *bicornis*, or *extensor carpi radialis*, are lodged.—The internal side of this end of the *radius* is also hollowed by the extensors of the first and second joint of the thumb; immediately above which, a little rough surface shews where the *supinator radii longus* is inserted.—The ridges at the sides of the grooves, in which the tendons play, have an annular ligament fixed to them, by which the several sheaths for the tendons are formed.—The fore-part of this end of the *radius* is also depressed, where the flexors of the fingers and *flexor carpi radialis* pass.—The external side is formed into a semilunated smooth cavity, lined with a cartilage, for receiving the lower end of the *ulna*.—The lowest part of the *radius* is formed into an oblong cavity; in the middle of which is a small transverse rising, gently hollowed, for lodging mucilaginous glands; while the rising itself is insinuated into the conjunction of the two bones of the wrist that are received into the cavity.—The internal side of this articulation is fenced by a remarkable process (g) of the *radius*, from which a

ligament

(g) *Malleolus internus, processus styloides.*

ligament goes out to the wrist, as the *styloid* process of the *ulna*, with its ligament guards it on the outside.

The ends of both the bones of the fore-arm being thicker than the middle, there is a considerable distance between the bodies of these bones; in the larger part of which a strong tendinous, but thin ligament, is extended, to give a large enough surface for the origin of the numerous fibres of the muscles situated here, that are so much sunk between the bones, as to be protected from injuries, which they would otherwise be exposed to. But this ligament is wanting near the upper end of the fore-arm, where the *supinator radii brevis*, and *flexor digitorum profundus*, are immediately connected (*b*).

Both ends of the bones of the fore-arm are first cartilages, and then *epiphyses* in children.

As the head of the *radius* receives the tubercle of the *os humeri*, it is not only bended and extended along with the *ulna*, but may be moved round its *axis* in any position; and that this motion round its *axis* may be sufficiently large, the ligament of the articulation is extended farther down than ordinary on the neck of this bone, before it is connected to it; and it is very thin at its upper and lower part, but makes a firm ring in the middle.—This bone is also joined to the *ulna* by a double articulation; for above, a tubercle of the *radius* plays in a socket of the *ulna*; whilst below, the *radius* gives the socket, and the *ulna* the tubercle: But then the motion performed in these two is very different; for at the upper end, the *radius* does no more than turn round its *axis*; while at the lower end, it moves in a sort of *cyclid* upon the round part of the *ulna*; and as the hand is articulated and firmly connected here with the *radius*, they must move together.—When the palm is turned uppermost, the *radius* is said to perform the *supination*; when the back of the hand is above, it is said to be *pronate*. But then the quickness and large extent of

these

(*b*) Weitbrecht, Syndesmolog. fig. 10, 11.

these two motions are assisted by the *ulna*, which, as was before observed, can move with a kind of small rotation on the sloping sides of the pulley. This lateral motion, though very inconsiderable in the joint itself, is conspicuous at the lower end of such a long bone; and the strong ligament connecting this lower end to the *carpus*, makes the hand more readily to obey these motions.—When we design a large circular turn of our hand, we increase it by the rotation of the *os humeri*, and sometimes employ the spine and *inferior extremities* to make these motions of pronation or supination of the hand large enough.

The *HAND* (*i*) comprehends all from the joint of the wrist to the points of the fingers. Its back-part is convex, for greater firmness and strength, and it is concave before, for containing more surely and conveniently such bodies as we take hold of.—One half of the hand has an obscure motion in comparison of what the other has, and serves as a base to the moveable half; which can be extended back very little farther than to a straight line with the fore-arm, but can be considerably bended forwards.

As the bones that compose the hand are of different shapes and uses, while several of them that are contiguous agree in some general characters; the hand is, on this account, commonly divided into the *carpus*, *metacarpus*, and *fingers*; among which last the thumb is reckoned.

The *CARPUS* (*k*) is composed of eight small spongy bones, situated at the upper part of the hand. I shall describe each of these bones, under a proper name taken from their figure (*l*); because the method of ranging them by numbers leaves anatomists too much at liberty to debate very idly, which ought to be preferred to the first number; or, which is worse, several, without explaining the order they observe, differently apply the same numbers, and so confound their readers.—But that the description of these bones

R

may

(*i*) Ἀρχεῖον, summa manus.

(*k*) Κρίς, brachiale, prima palmæ pars, rasetta.

(*l*) Lyser. Cult. anat. lib. 5. cap. 2.

may be in the same order as they are found in the generality of anatomical books, I shall begin with the range of bones that are concerned in the moveable joint of the wrist, or are connected to the fore-arm, and shall afterwards consider the four that support the thumb and *os metacarpi* of the fingers.

The eight bones of the *carpus* are, *os scaphoides*, *lunare*, *cuneiforme*, *pisiforme*, *trapezium*, *trapezoides*, *magnum*, *unciforme*.

The *scaphoides* is situated most internally of those that are articulated with the fore-arm.—The *lunare* is immediately on the outside of the former.—The *cuneiforme* is placed still more externally, but does not reach so high up as the other two.—The *pisiforme* stands forwards into the palm from the *cuneiforme*.—The *trapezium* is the first of the second row, and is situated betwixt the *scaphoides* and first joint of the thumb.—The *trapezoides* is immediately on the outside of the *trapezium*.—The *os magnum* is still more external.—The *unciforme* is farther to the side of the little finger.

Os scaphoides (*m*) is the largest of the eight except one. It is convex above, concave and oblong below; from which small resemblance of a boat it has got its name.—Its smooth convex surface is divided by a rough middle *fossa*, which runs obliquely across it.—The upper largest division is articulated with the *radius*.—Into the *fossa* the common ligament of the joint of the wrist is fixed; and the lower division is joined to the *trapezium* and *trapezoides*.—The concavity receives more than an half of the round head of the *os magnum*.—The external side of this hollow is formed into a semilunar plane, to be articulated with the following bone.—The internal, posterior, and anterior edges are rough, for fixing the ligaments that connect it to the surrounding bones.

Os lunare (*n*) has a smooth convex upper surface, by which it is articulated with the *radius*.—The internal

(*m*) Korvloesding, naviculare.

(*n*) Lunatum.

nal side, which gives the name to the bone, is in the form of a crescent, and is joined with the *scaphoid*;—the lower surface is hollow, for receiving part of the head of the *os magnum*.—On the outside of this cavity is another smooth, but narrow oblong sinuosity, for receiving the upper end of the *os unciforme*:—On the outside of which a small round convexity is found, for its connection with the *os cuneiforme*.—Between the great convexity above, and the first deep inferior cavity, there is a rough *fossa*, in which the circular ligament of the joint of the wrist is fixed.

Os cuneiforme (*p*) is broader above, and towards the back of the hand, than it is below and forwards; which gives it the resemblance of a wedge.—The superior slightly convex surface is included in the joint of the wrist, being opposed to the lower end of the *ulna*.—Below this the cuneiform bone has a rough *fossa*, wherein the ligament of the articulation of the wrist is fixed.—On the internal side of this bone, where it is contiguous to the *os lunare*, it is smooth and slightly concave.—Its lower surface, where it is contiguous to the *os unciforme* is oblong, somewhat spiral, and concave.—Near the middle of its anterior surface a circular plane appears, where the *os pisiforme* is sustained.

Os pisiforme (*q*) is almost spherical, except one circular plane, or slightly hollow surface, which is covered with cartilage for its motion on the cuneiform bone, from which its whole rough body is prominent forwards into the palm; having the tendon of the *flexor carpi ulnaris*, and a ligament from the *styloid* process of the *ulna*, fixed to its upper part; the transverse ligament of the wrist is connected to its internal side; ligaments extended to the *unciform* bone, and to the *os metacarpi* of the little finger, are attached to its lower part; the *abductor minimi digiti* has its origin from its fore-part; and, at the internal side of

R 2

it,

(*p*) *Triquetrum.*

(*q*) *Cartilaginosum, subrotundum, rectum.*

it, a small depression is formed, for the passage of the ulnar nerve.

Trapezium (r) has four unequal sides and angles in its back-part, from which it has got its name.—Above, its surface is smooth, slightly hollowed, and semicircular, for its conjunction with the *os scaphoides*.—Its external side is an oblong concave square, for receiving the following bone.—The inferior surface is formed into a pulley; the two protuberant sides of which are external and internal. On this pulley the first bone of the thumb is moved.—At the external side of the external protuberance, a small oblong smooth surface is formed by the *os metacarpi indicis*.—The fore-part of the *trapezium* is prominent in the palm, and, near to the external side, has a sinuosity in it, where the tendon of the *flexor carpi radialis* is lodged; on the ligamentous sheath of which the tendon of the *flexor tertii internodii pollicis* plays: And still more externally the bone is scabrous, where the *transverse ligament* of the wrist is connected, the *abductor* and *flexor primi internodii pollicis* have their origin, and ligaments go out to the first bone of the thumb.

Os trapezoides (s), so called from the irregular quadrangular figure of its back-part, is the smallest bone of the wrist except the *pisiforme*.—The figure of it is an irregular cube.—It has a small hollow surface above, by which it joins the *scaphoides*; a long convex one internally, where it is contiguous to the *trapezium*; a small external one, for its conjunction with the *os magnum*; and an inferior convex surface, the edges of which are however so raised before and behind, that a sort of pulley is formed, where it sustains the *os metacarpi indicis*.

Os magnum (t), so called because it is the largest bone of the *carpus*, is oblong, having four quadrangular sides, with a round upper end, and a triangular plain

(r) *Os cubiforme, trapezoides, multangulum majus.*

(s) *Trapezium, multangulum minus.*

(t) *Maximum, capitatum.*

plain one below.—The round head is divided by a small rising, opposite to the connection of the *os scaphoides* and *lunare*, which together form the cavity for receiving it.—On the inside a short plain surface joins the *os magnum* to the *trapezoides*.—On the outside is a long narrow concave surface, where it is contiguous to the *os unciforme*.—The lower end, which sustains the metacarpal bone of the middle finger, is triangular, slightly hollowed, and farther advanced on the internal side than on the external, having a considerable oblong depression made on the advanced inside by the metacarpal bone of the fore-finger; and generally there is a small mark of the *os metacarpi digiti annularis* on its external side.

Os unciforme (*u*) has got its name from a thin broad process that stands out from it forwards into the palm, and is hollow on its inside, for affording passage to the tendons of the flexors of the fingers. To this process also the transverse ligament is fixed, that binds down and defends these tendons; and the *flexor* and *abductor* muscles of the little finger have part of their origin from it.—The upper plain surface is small, convex, and joined with the *os lunare*:—The internal side is long, and slightly convex, adapted to the contiguous *os magnum*:—The external surface is oblique, and irregularly convex, to be articulated with the cuneiform bone:—The lower end is divided into two concave surfaces; the external is joined with the metacarpal bone of the little finger, and the internal one is fitted to the metacarpal bone of the ring-finger.

In the description of the preceding eight bones, I have only mentioned those plain surfaces covered with cartilage, by which they are articulated to each other, or to some other bones, except in some few cases, where something extraordinary was to be observed; and I have designedly omitted the other rough surfaces, lest, by crowding too many words in the description of such small bones, the whole should be

R 3

unintelligible:

(u) Cuneiforme.

unintelligible: But these scabrous parts of the bones may easily be understood, after mentioning their figure, if it is observed, that they are generally found only towards the back or palm of the hand; that they are all plain, larger behind than before; and that they receive the different ligaments, by which they are either connected to neighbouring bones, or to one another; for these ligaments cover all the bones, and are so accurately applied to them, that, at first view, the whole *carpus* of a recent subject appears one smooth bone (x).

As the surfaces of these bones are largest behind, the figure of the whole conjoined must be convex there, and concave before; which concavity is still more increased by the *os pisiforme*, and process of the *os unciforme*, standing forwards on one side, as the *trapezium* does on the other: And the bones are securely kept in this form, by the broad strong transverse ligament connected to these parts of them that stand prominent into the palm of the hand.—The convexity behind renders the whole fabric stronger, where it is most exposed to injuries; and the large anterior hollow is necessary for a safe passage to the numerous vessels, nerves, and tendons of the fingers.

The substance of these bones is spongy and cellular, but strong in respect of their bulk.

The three first bones of the *carpus* make an oblong head, by which they are articulated with the cavity at the lower ends of the bones of the fore-arm; so as to allow motion to all sides, and, by a quick succession of these motions, they may be moved in a circle. But as the joint is oblong, and therefore the two dimensions are unequal, no motion is allowed to the *carpus* round its axis, except what it has in the pronation and supination along with the *radius*.—The articulation of the first three bones of the superior row, with the bones of the inferior, is such as allows of motion, especially backwards and forwards;

to

(x) Galen de usu part. lib. 2. cap. 8. For a particular description of these ligaments, see Weitbrecht Syndesmolog. p. 5.—68.

to the security and easiness of which the reception of the *os magnum* into the cavity formed by the *scaphoides* and *lunare* contributes considerably: And the greatest number of the muscles that serve for the motion of the wrist on the *radius*, being inserted beyond the conjunction of the first row of bones with the second, act equally on this articulation as they do on the former; but the joint formed with the *radius* being the most easily moved, the first effect of these muscles is on it; and the second row of the *carpus* is only moved afterwards. By this means a larger motion of the wrist is allowed, than otherwise it could have had safely: For, if as large motion had been given to one joint, the angle of flexion would have been very acute, and the ligaments must have been longer than was consistent with the firmness and security of the joint.—The other articulations of the bones here being by nearly plain surfaces, scarce allow of any more motion, because of the strong connecting ligaments, than to yield a little, and so elude the force of any external power; and to render the back of the wrist a little more flat, or the palm more hollow, on proper occasions. The articulations of the thumb and metacarpal bones shall be examined afterwards.

The uses of the *carpus* are to serve as a base to the hand, to protect its tendons, and to afford it a free large motion.

All the bones of the *carpus* are in a cartilaginous state at the time of birth.

On account of the many tendons that pass upon the lower end of the fore-arm and the *carpus*, and of the numerous ligaments of these tendons and of the bones, which have lubricating liquors supplied to them, the pain of sprains here is acute, the parts take long time to recover their tone, and their swellings are very obstinate.

METACARPUS (x) consists of four bones which sustain the fingers.—Each bone is long and round, with

(x) Κτύς, προκαρπίον, στηθός, κυδηπόν, κτενίον, postbrachiale, pec-

tus, palma, pecten.

with its ends larger than its body.—The upper end, which some call the base, is flat and oblong, without any considerable head or cavity; but it is however somewhat hollowed, for the articulation with the *carpus*: It is made flat and smooth on the sides where these bones are contiguous to each other.—Their bodies are flattened on their back-part by the tendons of the extensors of the fingers.—The anterior surface of these bodies is a little concave, especially in their middle; along which a sharp ridge stands out, which separates the *musculi interossei* placed on each side of these bones which are there made flat and plain by these muscles.

Their lower ends are raised into large oblong smooth heads, whose greatest extent is forwards from the axis of the bone.—At the fore-part of each side of the root of each of these heads, one or two tubercles stand out, for fixing the ligaments that go from one metacarpal bone to another, to preserve them from being drawn asunder.—Round the heads a rough ring may be remarked, for the capsular ligaments of the first joints of the fingers to be fixed to; and both sides of these heads are flat, by pressing on each other.

The substance of the metacarpal bones is the same with that of all long bones.

At the time of birth, these bones are cartilaginous at both ends, which afterwards become *epiphyses*.

The metacarpal bones are joined above to the *os carpi* and to each other by nearly plain surfaces. These connections are not fit for large motions.—The articulation of their round heads at the lower ends with the cavities of the first bones of the fingers, is to be taken notice of hereafter.

The concavity on the fore-part of these metacarpal bones, and the placing their bases on the arched *corpus*, cause them to form a hollow in the palm of the hand, which is useful often to us.—The spaces between them lodge muscles, and their small motion makes them fit supporters for the fingers to play on.

Though

Though the *os metacarpi* so far agree, yet they may be distinguished from each other by the following marks.

The *os metacarpi indicis* is generally the longest.—Its base, which is articulated with the *os trapezoides*, is hollow in the middle.—The small ridge on the internal side of this oblong cavity is smaller than the one opposite to it, and is made flat on the side by the *trapezium*.—The exterior ridge is also smooth, and flat on its outside, for its conjunction with the *os magnum*; immediately below which, a semicircular smooth flat surface shews the articulation of this to the second metacarpal bone.—The back-part of this base is flattened, where the long head of the *extensor carpi radialis* is inserted; and its fore-part is prominent, where the tendon of the *flexor carpi radialis* is fixed.—The external side of the body of this bone is more hollowed by the action of muscles, than the internal.—The tubercle at the internal root of its head is larger than the external.—Its base is so firmly fixed to the bone it is connected with, that it has no motion.

Os metacarpi medii digitii is generally the second in length; but often it is as long as the former; sometimes it is longer; and frequently it appears only to equal the first by the *os magnum* being farther advanced downwards than any other bone of the wrist.—Its base is a broad superficial cavity, slanting outwards; the internal posterior angle of which is so prominent, as to have the appearance of a process.—The internal side of this base is made plain in the same way as the external side of the former bone, while its external side has two hollow circular surfaces, for joining the third metacarpal bone; and between these surfaces there is a rough *ossa*, for the adhesion of a ligament, and lodging mucilaginous glands.—The shorter head of the *bicornis* is inserted into the back-part of this base.—The two sides of this bone are almost equally flattened; only the ridge on the fore-part of the body inclines outwards.—

The

The tubercles at the fore-part of the root of the head are equal.—The motion of this bone is very little more than the first metacarpal one has; and therefore, these two firmly resist bodies pressed against them by the thumb, or fingers, or both.

Os metacarpi digitii annularis is shorter than the second metacarpal bone.—Its base is semicircular and convex, for its conjunction with the *os unciforme*.—On its internal side are two smooth covexitie^s, and a middle *fossa*, adapted to the second metacarpal bone.—The external side has a triangular smooth concave surface to join it with the fourth one.—The anterior ridge of its body is situated more to the out than to the inside.—The tubercles near the head are equal.—The motion of this third metacarpal bone is greater than the motion of the second.

Os metacarpi minimi digitii is the smallest and sharpest.—Its base is irregularly convex, and rises slanting outwards.—Its internal side is exactly adapted to the third metacarpal bone.—The external has no smooth surface, because it is not contiguous to any other bone; but it is prominent where the *extensor carpi ulnaris* is inserted.—As this *metacarpal* bone is furnished with a proper moving muscle, has the plainest articulation, is most loosely connected and least confined, it not only enjoys a much larger motion than any of the rest, but draws the third bone with it, when the palm of the hand is to be made hollow by its advancement forwards, and by the prominence of the thumb opposite to it.

The THUMB and four FINGERS are each composed of three long bones.

The *Thumb* (*y*) is situated obliquely in respect of the fingers, neither opposite directly to them, nor in the same plane with them.—All its bones are much thicker and stronger in proportion to their length, than the bones of the fingers are: Which was extremely necessary, since the thumb counteracts all the fingers.

The

(y) Αυτιχειρ, δικονδυλος, magnus digitus, pro manus.

The first bone of the thumb has its base adapted to the double pulley of the *trapezium*: For, in viewing it from one side to the other, it appears convex in the middle; but when considered from behind forwards, it is concave there.—The edge at the fore-part of this base is produced farther than any other part; and round the back-part of the base a rough *fossa* may be seen, for the connection of the ligaments of this joint.—The body and head of this bone are of the same shape as the *os metacarpi*; only that the body is shorter, and the head flatter, with the tubercles at the fore-part of its root larger.

The articulation of the upper end of this bone is uncommon: For, though it has protuberances and depressions adapted to the double pulley of the *trapezium*; yet it enjoys a circular motion, as the joints do where a round head of one bone plays in the orbicular socket of another; only it is somewhat more confined and less expeditious, but stronger and more secure, than such joints generally are.

This bone of children is in the same state with the metacarpal bones.

The second bone of the thumb has a large base formed into an oblong cavity, whose greatest length is from one side to the other.—Round it several tubercles may be remarked, for the insertion of ligaments.—Its body is convex, or a half round behind; but flat before, for lodging the tendon of the long flexor of the thumb, which is tied down by ligamentous sheaths that are fixed on each side to the angle at the edge of this flat surface.—The lower end of this second bone has two lateral round protuberances, and a middle cavity, whose greatest extent of smooth surface is forwards.

The articulation and motion of the upper end of this second bone is as singular as that of the former.—For its cavity being joined to the round head of the first bone, it would seem at first view to enjoy motion in all directions; yet, because of the strength of its lateral ligaments, oblong figure of the joint itself,

self, and mobility of the first joint, it only allows flexion and extension; and these are generally much confined.

The third bone of the thumb is the smallest, with a large base, whose greatest extent is from one side to the other.—This base is formed into two cavities and a middle protuberance, to be adapted to the pulley of the former bone.—Its body is rounded behind; but is flatter than in the former bone, for sustaining the nail.—It is flat and rough before, by the insertion of the *flexor tertii internodii*.—This bone becomes gradually smaller, till near the lower end, where it is a little enlarged, and has an oval scabrous edge.

The motion of this third bone is confined to flexion and extension.

The orderly disposition of the bones of the fingers into three rows, has made them generally obtain the name of three *phalanges* (z).—All of them have half round convex surfaces, covered with an *aponeurosis*, formed by the tendons of the *extensors*, *lumbricales*, and *interossei*, and placed directly backwards, for their greater strength; and their flat concave part is forwards, for taking hold more surely, and for lodging the tendons of the *flexor* muscles.—The ligaments for keeping down these tendons are fixed to the angles that are between the convex and concave sides.

The bones of the first *phalanx* (a) of the fingers answer to the description of the second bone of the thumb: Only that the cavity in their base is not so oblong; nor is their motion on the metacarpal bones so much confined: For they can be moved laterally or circularly, but have no rotation, or a very small degree of it, round their axis.

Both the ends of this first *phalanx* are in a cartilaginous state at the birth; and the upper one is afterwards affixed in form of an *epiphysis*.

The

(z) Σχταλιδæ, internodia, scuticula, agmina, acies, condyli articuli.

(a) Προκονδυλος.

The second bone (*b*) of the fingers has its base formed into two lateral cavities, and a middle protuberance; while the lower end has two lateral protuberances and a middle cavity; therefore, it is joined at both ends in the same manner, which none of the bones of the thumb are.

This bone is in the same condition with the former in children.

The third bone (*c*) differs nothing from the description of the third bone of the thumb, excepting in the general distinguishing marks; and therefore, the second and third *phalanx* of the fingers enjoy only flexion and extension.

The upper end of this third *phalanx* is a cartilage in a ripe child; and is only an *epiphysis* after, till the full growth of the body.

All the difference of the *phalanges* of the several fingers consists in their magnitude.—The bones of the *middle finger* (*a*) being the longest and largest,—those of the *fore-finger* (*b*) come next to that in thickness, but not in length, for those of the *ring-finger* (*c*) are a little longer. The *little finger* (*d*) has the smallest bones. Which disposition is the best contrivance for holding the largest bodies; because the longest fingers are applied to the middle largest periphery of such substances as are of a spherical figure (*e*).

The uses of all the parts of our *superior extremities* are so evident in the common actions of life, that it is needless to enumerate them here; and therefore I shall proceed to the last part of the skeleton. Only, lest I should seem to have forgot the small bones at the joints of the hand, I desire now to refer to the description of them, under the common title of *sesamoid*

S

mold

(b) Κονδυλοι.

(c) Μετακονδυλοι, ριζωνυχια.

(a) Καράπυγων, φραγκελος, infamis, impudicus, verpus, famosus, obsecenus.

(b) Δεκτικος, indicator, λιχανος, demonstrativus, salutaris.

(c) Ιατρικος, παραμεσος, δακτυλιωτης, επιβατης, annularis, medicus, cordis digitus.

(d) Μυων, οτιτης, auricularis, minimus.

(e) Galen. de usu part. lib. I. cap. 24.

inoid bones, which I have placed after the bones of the feet.

OF THE INFERIOR EXTREMITIES.

THE INFERIOR EXTREMITIES depend from the *acetabula* of the *os innominata*; are commonly divided into three parts, viz. the thigh, leg, and foot.

The THIGH (*f*) has only one bone; which is the longest of the body, and the largest and strongest of any of the cylindrical bones. The situation of it is not perpendicular; for the lower end is inclined considerably inwards; so that the knees are almost contiguous, while there is a considerable distance between the thigh-bones above; which is of good use to us, since sufficient space is thereby left for the external parts of generation, the two great *choace* of urine and *fæces*, and for the large thick muscles that move the thigh inwards; and at the same time this situation of the thigh-bones renders our progression quicker, surer, straighter, and in less room; for, had the knees been at a greater distance from each other, we must have been obliged to describe some part of a circle with the trunk of our body in making a long step, and, when one leg was raised from the ground, our centre of gravity would have been too far from the base of the other, and we should consequently have been in hazard of falling; so that our steps would neither have been straight nor firm; nor would it have been possible to walk in a narrow path, had our thigh-bones been otherwise placed. In consequence, however, of the weight of the body bearing so obliquely on the joint of the knee, by this situation of the thigh-bones, weak ricketty children become in-knee'd.

The upper end of the thigh-bone is not continued in a straight line with the body of it, but is set off obliquely

(f) Μερος, femen, coxa, agis, anchæ os, crus, femur.

obliquely inwards and upwards, whereby the distance here between these two bones at their upper part is considerably increased.—This end is formed into a large smooth round head (*g*), which is the greater portion of a sphere unequally divided.—Towards its lower internal part a round rough spongy pit is observable, where the strong ligament, commonly, but unjustly, called the *round one*, is fixed, to be extended from thence to the lower internal part of the receiving cavity, where it is considerably broader than near to the head of the thigh-bone.—The small part below the head, called the *cervix* of the *os femoris*, has a great many large holes into which the fibres of the strong ligament, continued from the capsular, enter, and are thereby surely united to it; and round the root of the neck, where it rises from the bone, a rough ridge is found, where the capsular ligament of the articulation itself is connected.—Below the back-part of this root, the large unequal protuberance called *trochanter major* (*b*), stands out; the external convex part of which is distinguished into three different surfaces, whereof the one on the fore-part is scabrous and rough, for the insertion of the *gluteus minimus*; the superior one is smooth, and has the *gluteus medius* inserted into it; and the one behind is made flat and smooth by the tendon of the *gluteus maximus* passing over it.—The upper edge of this process is sharp and pointed at its back-part, where the *gluteus medius* is fixed; but forwards it is more obtuse, and has two superficial pits formed in it: Into the superior of these, the *pyriformis* is implanted; and the *obturator internus* and *gemini* are fixed into the lower one.—From the backmost prominent part of this great *trochanter*, a rough ridge runs backwards and downwards, into which the *quadratus* is inserted.—In the deep hollow, at the internal upper side of this ridge, the *obturator externus* is implanted.—More internally, a conoid process called *trochanter minor* (*i*), rises for

(g) Vertebrum.

(b) Τραντός, rotator natis, malum granatum testiculorum.

(i) Rotator minor.

the insertion of the *musculus psoas* and *iliacus internus*; and the *pectineus* is implanted into a rough hollow below its internal root.—The muscles inserted into these two processess being the principal instruments of the rotatory motion of the thigh, have occasioned the name of *trochanteres* to the processess.—The tendons that are fixed into, or pass over the great *trochanter*, cause bruises by falls on this part to be attended with great pain and weakness of the limb, which generally remain long.

The body of the *os femoris* is convex on the fore-part, and made hollow behind, by the action of the muscles that move it and the leg, and for the conveniency of sitting, without bearing too much on these muscles; and probably the weight of the legs depending from the thighs in that posture, contributes to this curvature.—The fore-part of the thigh-bone is a little flattened above by the beginning of the *crureus* muscle, as it is also below by the same muscle and the *rectus*.—Its external surface is likewise made flat below by the *vastus externus*, where it is separated from the former by an obtuse ridge.—The *vastus internus* depresses a little the lower part of the internal surface.—The posterior concave surface has a ridge rising in its middle commonly called *linea aspera*, into which the *triceps* is inserted, and the short head of the *biceps flexor tibiae* rises from it.—At the upper part of it the medullary vessels enter by a small hole that runs obliquely upwards; a little above which there is a rough *fossa* or two, where the tendon of the *gluteus maximus* is fixed.—The lower end of the *linea aspera* divides into two, which descend towards each side.—The two *vasti* muscles have part of their origin from these ridges; and the long tendon of the *triceps* is fixed to the internal, by means of part of the *fascia aponeurotica* of the thigh.—Near the beginning of the internal ridge, there is a discontinuation of the ridge where the crural artery passes through the *aponeurosis*.—Between these two rough lines, the bone is made flat by the large blood-vessels and nerves which pass upon

upon it; and near the end of each of these ridges, a small smooth protuberance may often be remarked, where the two heads of the external *gastrocnemius* muscle take their rise, and where sesamoid bones are sometimes found (*k*); and from the fore-part of the internal tubercle, a strong ligament is extended to the inside of the *tibia*.

The lower end of the *os femoris* is larger than any other part of it, and is formed into a great protuberance on each side, called its *condyles*; between which a considerable cavity is found, especially at the back-part, in which the crural vessels and nerves lie immersed in fat.—The internal condyle is longer than the external, which must happen from the oblique position of this bone, to give less obliquity to the leg.—Each of these processes seems to be divided in its plain smooth surface. The mark of division on the external is a notch, and on the internal a small protuberance. The fore-part of this division, on which the *rotula* moves, is formed like a pulley, the external side of which is highest.—Behind, there are two oblong large heads, whose greatest extent is backwards, for the motion of the *tibia*; and from the rough cavity between them, but near to the base of the internal condyle, the strong ligament commonly called the *cross one*, has its rise;—a little above which a rough protuberance gives insertion to the tendon of the *triceps*.—The condyles, both on the outer and inner side of the knee, are made flat by the muscles passing along them.—On the back-part of the internal, a slight depression is made by the tendons of the *gracilis* and *sartorius*; and on the external such another is formed by the *biceps flexor cruris*; behind which a deep *fossa* is to be observed, where the *popliteus* muscle has its origin.—From the tubercle immediately before this cavity, a strong round ligament goes out to the upper part of the *fibula*.—Round this lower end of the thigh-bone, large holes are found, into which the ligaments for the security of the joint

are fixed, and blood-vessels pass to the internal substance of the bone.

All the processæ of the *femur* are cartilaginous in new-born children, and afterwards become small *apophyses*, with large *epiphyses*.

The thigh-bone being articulated above with the *acetabulum* of the *os innominata*, which affords its round head a secure and extensive play, can be moved to every side; but is restrained in its motion outwards, by the high brims of the cavity, and by the *round ligament*; for otherwise, the head of the bone would have been frequently thrust out at the breach of the brims on the inside, which allows the thigh to move considerably inwards.—The body of this bone enjoys little or no rotatory motion, though the head most commonly moves round its own axis; because the oblique progress of the neck and head from the bone is such, that the rotatory motion of the head can only bring the body of the bone forwards and backwards: Nor is this head, as in the arm, ever capable of being brought to a straight direction with its body; so far however as the head can move within the cavity backwards and forwards, the rest of the bone may have a partial rotation.—When the thigh-bone resists the actions of its muscles more than the trunk of the body can then do, as in standing, these muscles have their effect on the trunk, causing it to bend forward, raising it up, inclining it to the one or the other side, twisting it obliquely, &c. which the rolling of the *acetabula* of the *os innominata* on the round heads of the thigh-bones is well fitted for.—The *os femoris* is articulated below to the *tibia* and *rotula* in the manner afterwards to be described.

The nearness of the small neck to the round head of the thigh-bone, and its upper end being covered with very thick muscles, make greater difficulty in distinguishing between a luxation and fracture here, than in any other part of the body.

The *LEG* (*b*) is composed, according to the common

(b) *Kynun*, *crus*, *tibia*.

mon account, of two bones, *tibia* and *fibula*, though it seems to have a very good title to a third, the *rotula*; which bears a strong analogy to the *olecranon* of the *ulna*, and moves always with the other two.

TIBIA, (*c*), so called from its resemblance to an old musical pipe or flute, is the long thick triangular bone, situated at the internal part of the leg, and continued in almost a straight line from the thigh-bone.

The upper end of the *tibia* is large, bulbous, and spongy, and is divided into two cavities, by a rough irregular protuberance (*d*), which is hollow at its most prominent part, as well as before and behind. The anterior of the two ligaments that compose the great cross one, is inserted into the middle cavity, and the depression behind receives the posterior ligament.—The two broad cavities at the sides of this protuberance are not equal; for the internal is oblong and deep, to receive the internal *condyle* of the thigh-bone: while the external is more superficial and rounder, for the external *condyle*.—In each of these two cavities of a recent subject, a semilunar cartilage is placed, which is thick at its convex edge, and becomes gradually thinner towards the concave or interior edge.—The middle of each of these cartilages is broad, and the ends of them turn narrower and thinner, as they approach the middle protuberance of the *tibia*.—The thick convex edge of each cartilage is connected to the capsular and other ligaments of the articulation, but so near to their rise from the *tibia*, that the cartilages are not allowed to change place far; while the narrow ends of the cartilages becoming almost ligaments, are fixed at the insertion of the strong cross ligament into the *tibia*, and seem to have their substance united with it; therefore a circular hole is left between each cartilage and the ligament, in which the most prominent convex part of each condyle of the thigh-bone moves.—The circumference of these

(c) Προκυνημιον, διτικυνημιον, focile majus, arundo major, canna major, canna domestica cruris.

(d) Διαφυσις, εξοχη νευροχονκρωδης, tuber, tuberculum.

these cavities is rough and unequal for the firm connection of the ligaments of the joint.—Immediately below the edge at its back-part, two rough flattened protuberances stand out : Into the internal, the tendon of the *semimembranosus* muscle is inserted ; and a part of the cross ligament is fixed to the external.—On the outside of this last tubercle, a smooth slightly-hollowed surface is formed by the action of the *popliteus* muscle.

Below the fore-part of the upper end of the *tibia*, a considerable rough protuberance (*e*) rises, to which the strong tendinous ligament of the *rotula* is fixed.—On the internal side of this, there is a broad scabrous slightly-hollowed surface, to which the internal long ligament of the joint, the *aponeurosis* of the *vastus intermus*, and the tendons of the *seminervosus*, *gracilis*, and *sartorius*, are fixed.—The lowest part of this surface is therefore the place where the *tibia* ought to be sawed through in an amputation, so as not to have too long and troublesome a stump, and, at the same time, to preserve its motions, by saving the proper muscles.—Below the external edge of the upper end of the *tibia*, there is a circular flat surface, covered in a recent subject with cartilage, for the articulation of the *fibula* ;—between which and the anterior knob, there is a rough hollow from which the *tibialis anticus*, and *extensor digitorum longus*, take their origin.—From the smooth flat surface, a ridge runs obliquely downwards and inwards, to give rise to part of the *soleus*, *tibialis posticus*, and *flexor digitorum longus*, and insertion to the *aponeurosis* of the *semimembranosus* which covers the *popliteus*, and to some of the external fibres of this last named muscle.—At the inside of this ridge an oblique plain surface is left, where the greatest part of the *musculus popliteus* is inserted.—The remaining body of the *tibia* is triangular.—The anterior angle is very sharp, and is commonly called the *spine* or *spin* (*f*). This ridge is not straight;

(e) Ἀντεριοῦ, anterior tuber.

(f) Ακαθα, spina, crea, linea prima tibie, angulus acutus.

straight; but turns first inwards, then outwards, and lastly inwards again.—The plain internal side is smooth and equal, being little subjected to the actions of muscles; but the external side is hollowed above by the *tibialis anticus*, and below by the *extensor digitorum longus* and *extensor pollicis longus*.—The two angles behind these sides are rounded by the action of the muscles;—the posterior side comprehended between them is not so broad as those already mentioned, but is more oblique and flattened by the action of the *tibialis posticus* and *flexor digitorum longus*.—Some way above the middle of the bone the internal angle terminates, and the bone is made round by the pressure of the *musculus solaeus*.—Near to this, the passage of the medullary vessels is seen slanting obliquely downwards.

The lower end of the *tibia* is made hollow, but so as a small protuberance rises in the middle.—The internal side of this cavity, which is smooth, and in a recent subject is covered with cartilage, is produced into a considerable process, commonly named *malleolus internus* (*g*); the point of which is divided by a notch, and from it ligaments are sent out to the foot.—We ought to observe here, that this internal *malleolus* is situated more forwards than the internal condyle of the upper end of this bone; which is necessary to be remembered in reducing a fracture of the leg (*b*).—The external side of this end of the *tibia* has a rough irregular semilunar cavity formed in it, for receiving the lower end of the *fibula*.—The posterior side has two lateral grooves, and a small middle protuberance. In the internal depression, the tendons of the *musculus tibialis posticus* and *flexor digitorum longus* are lodged; and in the external, the tendon of the *flexor longus pollicis* plays.—From the middle protuberance, ligamentous sheaths go out, for tying down these tendons.

The articulations and motions of the *tibia* shall be explained,

(*g*) Σφυρον, πτερον, talus, clavica, clavilla interior, clavilla domestica.

(*b*) Winslow, Exposition anatomique des os sees, sect. 865.

explained, after all the three bones of the leg are described.

Both the ends of the *tibia* are cartilages at birth, and become afterwards *epiphyses*.

FIBULA (*i*) is the small long bone, placed on the outside of the leg, opposite to the external angle of the *tibia*; the shape of it is irregularly triangular.

The head of the *fibula* has a superficial circular cavity formed on its inside, which, in a recent subject, is covered with a cartilage, but so closely connected to the *tibia* by ligaments, as to allow only a small motion backwards and forwards.—This head is protuberant and rough on its outside, where a strong round ligament and the *musculus biceps* are inserted; and below the back-part of its internal side, a tubercle may be remarked, that gives rise to the strong tendinous part of the *soleus* muscle.

The body of this bone is a little crooked inwards and backwards, which figure is owing to the actions of the muscles; but is still further increased by nurses, who often hold children carelessly by the legs.—The sharpest angle of the *fibula* is forwards, on each side of which the bone is considerably, but unequally, depressed by the bellies of the several muscles that rise from, or act upon it; and, in old people, these muscles make distinct sinuosities for themselves.—The external surface of the *fibula* is depressed obliquely from above downwards and backwards, by the two *peronai*.—Its internal surface is unequally divided into two narrow longitudinal planes, by an oblique ridge extended from the upper part of the anterior angle, to join with the lower end of the internal angle. To this ridge the ligament stretched between the two bones of the leg is connected.—The anterior of the two planes is very narrow above, where the *extensor longus digitorum* and *extensor longus pollicis* arise from it; but is broader below, where it has the print of the *nodus Vesalii*.—The posterior plane is broad and hollow,

(i) Παραχνημόν, perone, focile minus, arundo minor, canna minor cruris, sura, radius.

hollow, giving origin to the larger share of the *tibialis posticus*.—The internal angle of this bone has a tendinous membrane fixed to it, from which fibres of the *flexor digitorum longus* take their rise.—The posterior surface of the *fibula* is the plainest and smoothest, but is made flat above by the *soleus*, and is hollowed below by the *flexor pollicis longus*.—In the middle of this surface the canal for the medullary vessels may be seen slanting downwards.

I have taken particular notice of the entry and direction of the medullary vessels of the large bones of the extremities (*a*) ; because, in several chirurgical cases, a surgeon, who is ignorant of this, may do mischief to his patient. Thus, for example, if these vessels are opened very near to their entry into the bone, or while they are in the oblique passage through it, an obstinate hæmorrhagy may ensue : For the arteries being connected to the bony passage, styptics, and other like corrugators, are vainly applied ; compressing instruments can do no service, and ligatures cannot be employed.—There seems to be a particular design in the contrivance of these canals ; those in the *os humeri*, *tibia*, and *fibula*, running obliquely downwards from their external entry ; whereas in the *radius*, *ulna*, and *os femoris*, they slant upwards, whereby the arteries and nerves which are sent into these three last bones, must suffer a considerable reflection before they come at the *cancelli*. The reason of this diversity may perhaps be, that the arteries, which are so small within the bones as to have no strong contractile propelling force in their coats, and where they are not assisted by the action of any moving neighbouring organ, should have, at least in their passage through the bone, a favourable descent for their liquids : Which, it is evident, they have in the descending oblique passages formed for them in the first class of bones, to wit, the *os humeri*, *tibia*, and *fibula*, which are generally depending ; and they also most frequently acquire the like advantage in the *radius*, *ulna*,

(*a*) Havers, Osteolog. nov. disc. I. p. 59.

ulna, and *os femoris*; because the hand, in the most natural posture, is higher than the elbow; and when we sit or lie, the lower end of the thigh bone comes to be at least as high raised as the upper. In standing and walking, or when the arms are moved, the blood must indeed ascend as it passes through the bones of the fore-arm and thigh; but the pressure of the muscles, then in action, on the vessels, before they enter the bones, is sufficient to compensate the disadvantage of their course. This reasoning seems to be still enforced, by observing, that this passage is always nearer the upper than the lower ends of these bones.

The lower end of the *fibula* is extended into a spongy oblong head, on the inside of which is a convex, irregular, and frequently a scabrous surface, that is received by the external hollow of the *tibia*, and so firmly joined to it by a very thin intermediate cartilage and strong ligaments, that it scarce can move.—Below this, the *fibula* is stretched out into a coronoid process, that is smooth, covered with cartilage on its internal side, and is there contiguous to the outside of the first bone of the foot, the *astragalus*, to secure the articulation. This process, named *malleolus externus*, being situated farther back than the internal *malleolus*, and in an oblique direction, obliges us naturally to turn the fore-part of the foot outwards (*b*). At the lower internal part of this process, a spongy cavity for mucilaginous glands may be remarked; from its point ligaments are extended to the *astragalus*, *os calcis*, and *os naviculare*, bones of the foot; and from its inside short strong ones go out to the *astragalus*. On the back-part of it a sinuosity is made by the tendons of the *peronaei* muscles.—When the ligament extended over these tendons from the one side of the depression to the other is broke, stretched too much, or made weak by a sprain, the tendons frequently start forwards to the outside of the *fibula*.

The conjunction of the upper end of the *fibula* with the *tibia* is by plain surfaces tipped with cartilage,

(*b*) Winslow, Mémoires de l'acad. des sciences, 1722.

lage, and at its lower end the cartilage seems to glue the two bones together, not, however, so firmly in young people, but that the motion at the other end of such a long *radius* is very observable.—In old subjects I often see the two bones of the leg grown together at their lower ends.

The principal use of this bone is to afford origin and insertion to muscles; the direction of which may be a little altered on proper occasions, by its upper part shuffling backwards and forwards.—It likewise helps to make the articulation of the foot more secure and firm.—The ends of the *tibia* and *fibula* being larger than their middle, a space is here left, which is filled up with such another ligament as I described extended between the bones of the fore-arm; and which is also discontinued at its upper part, where the *tibialis anticus* immediately adheres to the *soleus* and *tibialis posticus*; but every where else it gives origin to muscular fibres (*a*).

Both the ends of this bone are cartilaginous in a ripe child, and assume the form of *appendices* before they are united to its body.

ROTULA (*b*) is the small flat bone situated at the fore-part of the joint of the knee.—Its shape resembles the common figure of the heart with its point downwards.—The anterior convex surface of the *rotula* is pierced by a great number of holes, into which fibres of the strong ligament that is spread over it, enter.—Behind, its surface is smooth, covered with cartilage, and divided by a middle convex ridge into two cavities, of which the external is largest; and both are exactly adapted to the pulley of the *os femoris*, on which they are placed in the most ordinary unstraining postures of the leg; but when the leg is much bended, the *rotula* descends far down on the condyles; and when the leg is fully extended, the *rotula* rises higher, in its upper part, than the pulley

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(*a*) Weitbrecht, Syndesmolog. p. 156.

(*b*) Ἐπικυλίς, μυλαχρίς, κογχός, επιγονάτις, πλανχστερόν, patella, mola, genu, scutiforme os, cartilaginosum, disciforme, oculus genu.

of the thigh-bone.—The plain smooth surface is surrounded by a rough prominent edge, to which the capsular ligament adheres :—Below, the point of the bone is scabrous, where the strong tendinous ligament from the tubercle of the *tibia* is fixed.—The upper horizontal part of this bone is flattened and unequal, where the tendons of the extensors of the leg are inserted.

The substance of the *rotula* is cellular, with very thin external firm plates : But then these *cells* are so small, and such a quantity of bone is employed in their formation, that scarce any bone of its bulk is so strong. Besides, it is covered all over with a thick ligament, (as it was observed, that this sort of bones generally is), to connect its substance, and is moveable to one side or other ; therefore is sufficiently strong to resist the ordinary actions of the large muscles that are inserted into it, or any common external force applied to it ; while a fixed process, such as the *olecranon*, would not have been sufficient to bear the whole weight of our bodies, which frequently falls on it, and would have hindered the rotatory motion of the leg. Notwithstanding these precautions to preserve this bone from such injuries, yet I have seen a transverse fracture in it, when, by the report of the patient, and of the people about him, and by the want of swelling, discolouring, or other mark of bruise or contusion, it was plain the bone was broken by the violent straining effort of the muscles (*c*). Though my patient recovered the use of the joint of the knee, yet I think it reasonable to believe, that this sort of fracture is commonly attended with difficulty of motion, after the broken parts of the *rotula* are reunited ; because the callous matter probably extends itself into the cavity of the joint, where it either grows to some of the parts, or makes such an inequality on the surface of this bone, as does not allow it to perform the necessary motions on the condyles of the *femur* (*d*).

At

(*c*) See Ruysh. Observ. anat. chirurg. obsf. 3.

(*d*) Pare, liv. 15. cap. 22.

At the ordinary time of birth, the *rotula* is entirely cartilaginous, and scarcely assumes a bony nature so soon as most *epiphyses* do.

The parts which constitute the joint of the knee being now described, let us examine what are its motions, and how performed.—The two principal motions are flexion and extension.—In the former of these, the leg may be brought to a very acute angle with the thigh, by the condyles of the thigh-bones being round and made smooth far backwards. In performing this the *rotula* is pulled down by the *tibia*.—When the leg is to be extended, the *rotula* is drawn upwards, consequently the *tibia* forwards by the *extensor* muscles; which, by means of the protuberant joint, and of this thick bone with its ligament, have in effect the chord, with which they act, fixed to the *tibia* at a considerable angle, therefore act with advantage; but are restrained from pulling the leg farther than to a straight line with the thigh, by the posterior part of the *cross* ligament, that the body might be supported by a firm perpendicular column: For at this time the thigh and leg are as little moveable in a rotatory way, or to either side, as if they were one continued bone.—But when the joint is a little bended, the *rotula* is not tightly braced, and the posterior ligament is relaxed; therefore this bone may be moved a little to either side, or with a small rotation in the superficial cavities of the *tibia*; which is done by the motion of the external cavity backwards and forwards, the internal serving as a sort of axis (a). Seeing then one part of the *cross* ligament is situated perpendicularly, and the posterior part is stretched obliquely from the internal condyle of the thigh outwards, that posterior part of the *cross* ligament prevents the leg's being turned at all inwards; but it could not hinder it from turning outwards almost round, was not that motion confined by the lateral ligaments of this joint, which can yield little.

T 2

This

(a) Winslow, Exposition anatomique du corps humain, traité des os sœurs, § 976.

This rotation of the leg outwards is of good advantage to us in crossing our legs, and turning out feet outwards, on several necessary occasions; though it is altogether fit this motion should not be very large, to prevent frequent luxations here. While all these motions are performing, the part of the *tibia* that moves immediately on the condyles is only so much as is within the cartilaginous rings, which, by the thickness on their outsides, make the cavities of the *tibia* more horizontal, by raising their external side where the surface of the *tibia* slants downwards. By this means the motions of this joint are more equal and steady than otherwise they would have been. The cartilages being capable of changing a little their situation, are fit for doing this good office in the different motions and postures of the member, and likewise contribute to make the motions larger and quicker.

On account of the very large surface of the bones forming the joint of the knee, and the many strong ligaments connecting them, luxations seldom happen here. But these very ligaments, the *aponeurosis* passing over this joint, the quantity of fat and mucilaginous glands necessary for lubricating it, make it more subject to *white-swellings*, drop-sies, and such other disorders, than any other joint of the body.

The *FOOT* is divided, as well as the hand, into three parts, *viz.* *tarsus*, *metatarsus*, and *toes*: In the description of which, the several surfaces shall be named, according to their natural situation, *viz.* the *broad* of the foot, shall be called *superior*; the *sole*, *inferior*; the side on which the great toe is, *internal*; that where the little toe is, *external*.

The *tarsus* (a) consists of seven spongy bones; to wit, the *astragalus*, *os calcis*, *naviculare*, *cuboides*, *cuneiforme externum*, *cuneiforme medium*, and *cuneiforme internum*.

The *astragalus* is the uppermost of these bones.—The *os calcis* is below the *astragalus*, and is considerably prominent backwards beyond the other bones, to form the heel.—The *os naviculare* is in the middle of the

(a) *Raffetta.*

the internal side of the *tarsus*.—The *os cuboides* is the most external of the row of four bones at its fore-part.—The *os cuneiforme externum* is placed at the infide of the *cuboid*.—The *cuneiforme medium* is between the *external* and *internal cuneiform* bones, and the *internal cuneiform* is put at the internal side of the foot.

That the description of these bones may not be immoderately swelled with repetition, I desire, once for all, to observe, That wherever a ridge is mentioned, without a particular use assigned, a ligament is understood to be fixed to it; or where a spongy rough cavity, depression, or *fosſa* is remarked, without naming its use, a ligament is inserted, and mucilaginous glands are lodged: For such will occur in the detail of each of these bones.

The upper part of the *astragalus* (*b*) is formed into a large smooth head (*c*), which is slightly hollowed in the middle; and therefore resembles a superficial pulley, by which it is fitted to the lower end of the *tibia*.—The internal side of this head is flat and smooth, to play on the internal *malleolus*.—The external side has also such a surface, but larger, for its articulation with the external *malleolus*.—Round the base of this head there is a rough *fosſa*; and, immediately before the head, as also below its internal smooth surface, we find a considerable rough cavity.

The lower surface of the *astragalus* is divided by an irregular deep rough *fosſa*; which at its internal end is narrow, but gradually widens, as it stretches obliquely outwards and forwards.—The smooth surface, covered with cartilage, behind this *fosſa*, is large, oblong, extended in the same oblique situation with the *fosſa*, and concave, for its conjunction with the *os calcis*.—The back-part of the edge of this cavity is produced into two sharp-pointed rough processes, between which is a depression made by the tendon of the *flexor pollicis longus*.—The lower surface before

(b) *Astros*, talus, balistæ *os*, *malleolus*, *chaib*, *quatrio*, *os tesse*—*rae*, *claviculae*, *unciforme*.

(c) *Terrapous*.

the *fossa* is convex, and composed of three distinct smooth planes. The long one behind, and the exterior or shortest, are articulated with the heel-bone; while the internal, which is the most convex of the three, rests and moves upon a cartilaginous ligament, that is continued from the *calcaneum* to the *os scaphoides*. Without which ligament, the *astragalus* could not be sustained, but would be pressed out of its place by the great weight it supports, and the other bones of the *tarsus* would be separated. Nor would a bone be fit here, because it must have been thicker than could conveniently be allowed; otherwise it would break, and would not prove such an easy bending base, to lessen the shock which is given to the body in leaping, running, &c.

The fore-part of this bone is formed into a convex oblong smooth head, called by some its process, which is received by the *os naviculare*. Round the root of this head, especially on the upper surface, a rough *fossa* may be remarked.

The *astragalus* is articulated above to the *tibia* and *fibula*, which together form one cavity. Though, in this articulation, the bones have prominencies and cavities so small, as might allow motions in all directions; yet the flexion and extension are the most considerable, the other motions being confined by the *malleoli*, and by the strong ligaments which go out from the points of these processes to the *astragalus* and *os calcis*.—When the foot is bended, so far as it is commonly when we stand, no lateral or rotatory motion is allowed in this joint; for then the head of the *astragalus* is sunk deep between the *malleoli*, and the ligaments are tense; but when the foot is extended, the *astragalus* can move a little to either side, and with a small rotation. By this contrivance the foot is firm, when the weight of the body is to be supported on it; and when a foot is raised, we are at liberty to direct it more exactly to the place we intend next to step upon.—The *astragalus* is joined below, to the *os calcis*; and before, to the *os naviculare*, in

the

the manner to be explained, when these bones are described.

A considerable share of this bone is ossified in a new-born infant.

Calcaneum (d) is the largest bone of the seven.—Behind, it is formed into a large knob, commonly called the *heel*: The surface of which is rough behind, where the *tendo Achillis* is inserted into it; and above it, it is hollow and spongy. Farther forwards, on the upper surface of the *calcaneum*, there is an irregular oblong smooth convexity, adapted to the concavity at the back-part of the *astragalus*: And beyond this a narrow *fossa* is seen, which divides it from two small concave smooth surfaces, that are joined to the fore-part of the *astragalus*.—Behind the posterior of these smooth surfaces, which is the largest, a small sinuosity is made by the tendon of the *flexor digitorum longus*; at the fore-part of which a small rough protuberance appears, that gives rise to the *musculus extensor digitorum brevis*.

The external side of this bone is flat, with a superficial *fossa* running horizontally, in which the tendon of the *musculus peronaeus longus* is lodged.—The internal side of the heel-bone is hollowed, for lodging the origin of the *massa cornea Jac. Sylvii*, and for the safe passage of tendons, nerves, and arteries.—Under the side of the internal smooth concavity, a particular groove is made by the tendon of the *flexor pollicis longus*; and from the thin protuberance on this internal side, the cartilaginous ligament that supports the *astragalus*, goes out to the *os naviculare*; on which ligament, and on the edge of this bone to which it is fixed, the groove is formed for the tendon of the *flexor digitorum profundus*.

The lower surface of this bone is pressed flat at the back-part, by the weight of our bodies; and immediately before this plane, there are two tubercles, from the internal of which the *musculus abductor pollicis, flexor digitorum sublimis*, as also part of the *apo-neurosis*,

(d) *Os calcis, πτεργα, calcar pedis.*

neurosis plantaris, and of the *abductor minimi digiti*, have their origin; and the other part of the *abductor minimi digiti* and *aponeurosis plantaris* rises from the external.—Before these protuberances this bone is concave, for lodging the flexor muscles; and at its fore-part we may observe a rough depression, from which, and a tubercle behind it, the ligament goes out that prevents this bone to be separated from the *os cuboides*.

The fore-part of the *os calcis* is formed into an oblong pulley-like smooth surface, which is circular at its upper external end, but is pointed below. This smooth surface is fitted to the *os cuboides*.

Though the surfaces by which the *astragalus* and *os calcis* are articulated, seem fit enough for motion; yet the very strong ligaments by which these bones are connected, prevent it, and render this principal part of our base, which rests on the ground, *to wit*, the *os calcis*, firm.

A large share of the heel-bone is ossified at the ordinary time of birth, and the large knob appears afterwards in form of an *epiphysis*.

Os naviculare (*e*), is somewhat circular.—It is formed into an oblong concavity behind for receiving the anterior head of the *astragalus*.—On the upper surface there is a rough *fossa*.—Below, the *os naviculare* is very unequal and rough; but hollow for the safety of the muscles.—On its inside a large knob rises out, from which the *abductor pollicis* takes in part its origin, the tendon of the *tibialis posticus* is inserted into it, and to it two remarkable ligaments are fixed; the first is the strong one, formerly mentioned, which supports the *astragalus*; the second is stretched from this bone obliquely cross the foot, to the metatarsal bones of the middle toe, and of the toe next to the little one.—On the outside of the *os naviculare* there is a semicircular smooth surface, where it is joined to the *os cuboides*.—The fore-part of this bone is all covered

(e) Συζεύξις, or cymbæ.

covered with cartilage, and is divided into three smooth planes, fitted to the three *os cuneiformia*.

The *os naviculare* and *astragalus* are joined as a ball and socket, and the *naviculare* moves in all directions in turning the toes inwards, or in raising or depressing either side of the foot, though the motions are greatly restrained by the ligaments which connect this to the other bones of the *tarsus*.—A weakness of these ligaments causes sometimes an unnatural turn of the fore-part of the foot inwards.

The *os naviculare* is wholly cartilaginous in a new-born infant.

OS CUBOIDES (*a*) is a very irregular cube.—Behind, it is formed into an oblong unequal concavity, adapted to the fore-part of the *os calcis*.—On its internal side, there is a small semicircular smooth cavity, to join the *os naviculare*.—Immediately before which, an oblong smooth plane is made by the *os cuneiforme externum*.—Below this, the bone is hollow and rough.—On the internal side of the lower surface, a round protuberance and *fossa* are found, where the *musculus abductor pollicis* has its origin. On the external side of this same surface, there is a round knob, covered with cartilage; immediately before which, a smooth *fossa* may be observed, in which the tendon of the *peroneus primus* runs obliquely cross the foot; and on the knob, the thin flat cartilage proper to this muscle plays; in place of which, sometimes a bone is found: More externally than the knob, a rough hollow is made, for the strong ligaments stretched betwixt this bone and the *os calcis*.—Before, the surface of the *os cuboides* is flat, smooth, and slightly divided into two planes, for sustaining the *os metatarsi* of the little toe, and of the toe next to it.

The form of the back-part of the *os cuboides*, and the ligaments connecting the joint there with the *os calcis*,

(*a*) Πολυμορφόν, cubiforme, quadratum, grandinosum, varium, tesserae, multiforme.

calcis, both concur in allowing little motion in this part.

The ossification of this bone is scarcely begun at the birth.

Os cuneiforme externum (b), if we regard its situation or *medium* by its bulk, is much of the shape of a wedge, being broad and flat above, with long sides running obliquely downwards, and terminating in a sharp edge.—The upper surface of this bone is an oblong square.—The one behind is nearly a triangle, but not complete at the inferior angle, and is joined to the *os naviculare*.—The external side is an oblong square, divided as it were by a diagonal; the upper half of it is smooth, for its conjunction with the *os cuboides*: The other is a scabrous hollow, and in its superior anterior angle a small smooth impression is made by the *os metatarsi* of the toe next to the little one.—The internal side of this bone is also quadrangular, with the fore-part of its edge made flat and smooth by the *os metatarsi* of the toe next to the great one, and the back-part is also flat and smooth where the *os cuneiforme medium* is contiguous to it.—The fore-part of this bone is an oblong triangle, for sustaining the *os metatarsi* of the middle toe.

Os cuneiforme medium, or *minimum*, is still more exactly the shape of a wedge than the former.—Its upper part is square;—its internal side has a flat smooth surface above and behind, for its conjunction with the following bone; with a small rough *ossa* below; and a considerable share of it is rough and hollow.—The external side is smooth and a little hollowed, where it is contiguous to the last described bone.—Behind, this bone is triangular, where it is articulated with the *os naviculare*; and it is also triangular at its fore-part, where it is contiguous to the *os metatarsi* of the toe next to the great one.

Os cuneiforme maximum, or *internum*, differs from the two former in its situation, which is more oblique than theirs.—Besides, its broad thick part is placed

(b) Chalcoideum externum.

placed below, and the small thin point is above and outwards; while its under broad surface is concave, for allowing a safe passage to the flexors of the great toe.—The surface of this *os cuneiforme* behind, where it is joined to the *os naviculare*, is hollow, smooth, and of a circular figure below, but pointed above.—The external side consists of two smooth and flat surfaces, whose direction is nearly at right angles with each other. With the posterior, that runs obliquely from below forwards and upwards, the *os cuneiforme minimum* is joined; and with the anterior, whose direction is longitudinal, the *os metatarsi* of the toe next to the great one is connected.—The fore-part of this bone is semilunar, but flat and smooth, for sustaining the *os metatarsi* of the great toe.—The internal side is scabrous, with two remarkable tubercles below, from which the *musculus abductor pollicis* rises, and the *tibialis anticus* is inserted into its upper part.

The three cuneiform bones are all so secured by ligaments, that very little motion is allowed in any of them; and they are cartilaginous in a *fœtus* of nine months.

These seven bones of the *tarsus*, when joined, are convex above, and leave a concavity below, for lodging safely the several muscles, tendons, vessels, and nerves, that ly in the sole of the foot.—In the recent subject, their upper and lower surfaces are covered with strong ligaments which adhere firmly to them; and all the bones are so tightly connected by these and the other ligaments, which are fixed to the rough ridges and *fossa* mentioned in the preceding description of the particular bones, that, notwithstanding the many surfaces covered with cartilage, some of which are of the form of the very moveable articulations, no more motion is here allowed, than only to prevent too great a shock of the fabric of the body in walking, leaping, &c. by falling on too solid a base; which, if it was one continued bone, would likewise be much more liable to be broken; and in order

order to make our foot accommodate itself to the surfaces we tread on, by becoming more or less hollow, or by raising or depressing either side of it, as might be judged by what was said of the particular bones.

Sprains here occasion, as in the wrist, great pain and obstinate tumours, which too often cause carious bones.

METATARSUS (*c*) is composed of five bones, which, in their general characters, agree with the metacarpal bones; but may be distinguished from them by the following marks: 1. They are longer, thicker, and stronger. 2. Their anterior round ends are not so broad, and are less in proportion to their bases. 3. Their bodies are sharper above and flatter on their sides, with their inferior ridge inclined more to the outside. 4. The tubercles at the lower parts of the round head are larger.

The first or internal metatarsal bone is easily distinguished from the rest by its thickness.—The one next to it is the longest, and with its sharp edge almost perpendicular.—The others are shorter and more oblique, as their situation is more external. Which general remarks, with the description I am now to give of each, may teach us to distinguish them from each other.

Os metatarsi pollicis is by far the thickest and strongest, as having much the greatest weight to sustain. Its base is oblong, irregularly concave, and of a semilunar figure, to be adapted to the *os cuneiforme maximum*.—The inferior edge of this base is a little prominent and rough, where the tendon of the *peroneus primus* muscle is inserted.—On its outside an oblique circular depression is made by the second metatarsal bone.—Its round head has generally on its fore-part a middle ridge, and two oblong cavities, for the *ossa sesamoidea*; and on the external side a depression is made by the following bone.

Os

(c) Στυθος, πεδιον, planta, planum, vestigium, solium, pectus, praecordium, pectusculum.

Os metatarsi of the second toe, is the longest of the five, with a triangular base supported by the *os cuneiforme medium* and the external side produced into a process; the end of which is an oblique smooth plane, joined to the *os cuneiforme externum*.—Near the internal edge of the base, this bone has two small depressions, made by the *os cuneiforme maximum*, between which is a rough cavity.—Farther forwards we may observe a smooth protuberance, which is joined to the foregoing bone.—On the outside of the base are two oblong smooth surfaces, for its articulation with the following bone; the superior smooth surface being extended longitudinally, and the inferior perpendicularly; between which there is a rough *fossa*.

Os metatarsi of the middle toe, is the second in length.—Its base, supported by the *os cuneiforme externum*, is triangular, but slanting outwards, where it ends in a sharp-pointed little process; and the angle below is not completed.

The internal side of this base is adapted to the preceding bone; and the external side has also two smooth surfaces covered with cartilage, but of a different figure; for the upper one is concave, and, being round behind, turns smaller as it advances forwards; and the lower surface is little, smooth, convex, and very near the edge of the base.

Os metatarsi of the fourth toe, is near as long as the former, with a triangular slanting base joined to the *os cuboides*, and made round at its external angle, having one hollow smooth surface on the outside, where it is pressed upon by the following bone, and two on the internal side, corresponding to the former bone; behind which is a long narrow surface impressed by the *os cuneiforme externum*.

Os metatarsi of the little toe, is the shortest, situated with its two flat sides above and below, and with the ridges laterally.—The base of it, part of which rests on the *os cuboides*, is very large, tuberous, and produced into a long-pointed process externally, where

part of the *abductor minimi digiti* is fixed; and into its upper part the *peroneus secundus* is inserted.—Its inside has a flat conoidal surface, where it is contiguous to the preceding bone.

When we stand, the fore-ends of these metatarsal bones, and the *os calcis*, are our only supporters; and therefore it is necessary they should be strong, and should have a confined motion.

The bones of the *TOES* are much a-kin to those of the thumb and fingers; particularly the two of the great toe are precisely formed as the two last of the thumb; only their position, in respect of the other toes, is not oblique; and they are proportionally much stronger, because they are subjected to a greater force; for they sustain the force with which our bodies are pushed forwards by the foot behind at every step we make; and on them principally the weight of the body is supported, when we are raised on our tiptoes.

The three bones in each of the other four toes, compared to those of the fingers, differ from them in these particulars.—They are less, and smaller in proportion to their lengths:—Their bases are much larger than their anterior ends: Their bodies are more narrow above and below, and flatter on the sides.—The first *phalanx* is proportionally much longer than the bones of the second and third, which are very short.

Of the four, the toe next to the great one, has the largest bones in all dimensions, and more externally the toes are less.—The little toe, and frequently that next to it, have the second and third bones intimately united into one; which may be owing to their little motion, and the great pressure they are subjected to.

The toes are of good use to us in walking: for, when the sole is raised, they bring our body, with its centre of gravity, perpendicular to the advanced foot.

The

The bones of the *metatarsus* and toes, are in the same condition in children as those of the *metacarpus* and fingers.

The only bones now remaining to complete the description of the skeleton, are the small ones, which are found at the joints of the fingers and toes, and in some other parts, called

OSSA SESAMOIDEA, which are of very different figures and sizes, though they are generally said to resemble the seed of the *sesamum*.—They seem to me nothing else than the ligaments of the articulations, or the firm tendons of strong muscles, or both, become bony, by the compression which they suffer. Thus the *sesamoid* bones at the beginning of the *gastrocnemii* muscles, are evidently composed of the tendinous fibres only.—These, at the first joint of the great toe, are as plainly the same continued substance with the ligaments and the tendons of the *adductor*, *flexor, brevis*, and *abductor*.—That which is sometimes double at the second joint of that toe, is part of the capsular ligament; and if we enumerate the other *sesamoid* bones that are at any time found, we may observe all of them formed in this manner.—Their number, figure, situation, and magnitude, are so uncertain, that it were in vain to insist on the differences of each; and therefore I shall only in general remark,

1. That where-ever the tendons and ligaments are firmest, the actions of the muscles strongest, and the compression greatest, there such bones are most commonly found.

2. That, *ceteris paribus*, the older the subject is in which they are sought, their number is greater, and their size is larger.

3. The more labour any person is inured to, he has, *ceteris paribus*, the most numerous and largest *ossa sesamoidea*.

However, as the two at the first joint of the great toe are much larger than any other, are early formed, and are seldom wanting in an adult, we may

judge, that besides the more forcible cause of their formation, there should also be some particular advantage necessary at this place, rather than elsewhere, which may possibly be, to allow the *flexor* muscles to send their tendons along this joint, secure from compression in the hollow between the two oblong sesamoid bones; while, by removing these tendons from the centre of motion, and giving them the advantage of an angle at their insertion, the force of the muscles is increased, and therefore the great superincumbent weight of our body in progression is more easily raised.

APPEN-

A P P E N D I X.

Of the Marks of a FEMALE SKELETON.

TO finish the description of the bones, is generally to conclude the *osteology*; but that no part of the subject may be left untouched, I think it necessary to subjoin the distinguishing marks of the male and female skeletons; and have chosen to illustrate them principally in the latter; because women having a more delicate constitution, and affording lodging and nourishment to their tender *fœtuses*, till they have sufficient strength and firmness to bear the injuries of the atmosphere, and contact of other more solid substances, their bones are frequently incomplete, and always of a make in some parts of the body different from those of the robust male; which agree to the description already given, unless where the proper specialities of the female were particularly remarked; which could not be done in all places where they occur, without perplexing the order of this treatise: Therefore I chose rather to sum them up here by way of *Appendix*.

The causes of the following specialities of the female bones may be reduced to these three: 1. A weak lax constitution. 2. A sedentary inactive life, increasing that constitution. 3. A proper frame for being mothers.

The bones of women are smaller in proportion to their length than those of men; because the force of their muscles is not so great, nor is such strong external force applied to them to prevent their stretching out in length.

The depressions, ridges, scabrous surfaces, and other inequalities made by the muscles, are not so conspicuous

conspicuous in them; because their muscles are neither so thick nor strong, nor so much employed, to make so strong prints on their bones.

Their *os frontis* is more frequently divided by a continuation of the *sagittal* suture, which depends on the first and second general causes assigned above, for the specialities in their bones; as will appear after reflecting on the account given formerly of the middle internal spine of this bone.

Their *clavicles* are less crooked; because their arms have been less forcibly pulled forwards, which in our European women, especially those of distinction, is more hindered by their garb.

Their *sternum* is more raised by long cartilages below, that the *thorax* might be there widened in some proportion to what it is shortened by the pressure upon the *diaphragm*, when they are with child.

The defect of bone, or the hole in the middle of the *sternum*, is oftener found in them, to allow the passage of the mammary vessels, say some; but, in my opinion, this is owing to a lax constitution, by which the ossification is not so soon completed as in men, where the action of the solids is vigorous, and the circulation of the fluids is brisk; for a much smaller hole might have served this purpose; and the branches of the internal mammary vessels which are sent to the external parts of the *thorax*, do not pass here, but between the cartilages of the ribs, before these are joined to the *sternum*.

The *cartilago xiphoides*, is oftener bifurcated in women than men, for the reason assigned in the preceding paragraph, viz. a less forcible power of ossification.

The superior cartilages of the ribs sooner ossify, to support the weight of the *mammae*.

The middle cartilages are more flat and broad by the weight of the breasts.

The inferior cartilages are longer, for enlarging the chest.

Weak

Weak women, who have born many children when young, often have the *vertebrae* of their back bended forwards, and their *sternum* depressed, or become round-shouldered and flat-breasted (*a*), by the pressure and weight of the impregnated *uterus*, and by the strong action of the abdominal muscles.

The *os sacrum* is broader, and turned much more backwards, for enlarging the *pelvis*.

The *os coccygis* is more moveable, and much less bended forwards, to facilitate the birth.

The *ossa ilium* are more hollow, and more reflected outwards, and consequently further removed from each other, in order to widen the lower part of their *abdomen*, and for the better support of the impregnated *uterus*.

The ridge on the upper part of the *os pubis*, is larger in such women as have born children, being extended by the strong action of the *musculi recti abdominis*.

The cartilage between the two *ossa pubis*, especially in women who have born children, is thicker than in men, by which the *pelvis* is more capacious in females.

The conjoined surfaces of the *ossa pubis*, and of the *ossa innominata* and *sacrum* are less, the angle under the *symphysis* of the *ossa pubis*, is much larger, and the arches formed below and behind by the *ossa ilium* and *ischium* are wider, which, with the straighter *os sacrum*, and more distant *tubera ischii*, leave a larger passage for the exclusion of the child in birth.

The great tuberosity of the *ossa ischium*, is flatter in women than in men, because it is more pressed upon in the sedentary life which females enjoy.

In consequence of the *pelvis* of women being wider, the articulations of their thigh-bones must be farther removed from each other: and therefore a larger space is left for the procreation and birth of children (*b*); which distance of the thighs, may be one

(*a*) Cheldeon's Anatomy, book I. chap. 3.

(*b*) Albin. de ossib. § 339.

one reason why women in running generally shuffle more from one side to the other than men, to preserve the centre of gravity of their bodies from falling too far to a side of the joint of the thigh that supports them when the other is raised, which would endanger their tumbling to the ground.

N-

I N D E X.

A.

- A** Cetabulum of ossa innominata, 158.
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 Apophyses, their different sorts, uses, 18, 19. Many so named are epiphyses, 19.
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 Astragalus, 221. Its articulation, 222. Of children, 228.
 Atlas, or the first vertebra of the neck, 133. Of infants, 134.
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Med. - Anat. & Phys.
S Nerves.

THE
ANATOMY
OF THE
HUMAN NERVES,
AND
A DESCRIPTION of the HUMAN
LACTEAL SAC and DUCT.

The TENTH EDITION.

By ALEXANDER MONRO Senior, M. D. and P. A.

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P R E F A C E

To the SEVENTH EDITION.

BEING informed that the following Essays have been useful to the students in anatomy, I have caused them to be reprinted, with such amendments as I thought necessary.

That offence might not be given, I have treated all the opinions concerning the disputed physiology of the nerves with that deference which the uncertainty of the subject required; and have not only concealed the names of the writers whose sentiments were different from mine, but have shunned quotations from those whom I approve, lest the knowledge of the latter should be a key to discover the former by.

Descriptions of the very minute ramifications of the nerves are obscure to the young gentlemen for whose use I write; and therefore I have taken notice only of the larger branches in the description of the particular nerves.

The first occasion of my publishing my great Master Boerhaave's doctrine concerning the Systole and Diastole of the heart, was to prevent the imputation I might have lain under of assuming it to myself, when my worthy Master and good friend Mr. Cheselden inserted it into his anatomy, as communicated by me, without mentioning

mentioning Boerhaave's name. Having now taken away all grounds of such imputation, and the doctrine, though simple and beautiful, not appearing sufficient to account for the phænomena of the motions of the heart, I have omitted it in this edition.

The description of the receptaculum chyli and thoracic duct is more accurate, than in the common systems of anatomy; and on that account is here republished.

The corrections and additions made in this edition of the anatomy of the bones, and of these Essays, show, that I pretend not to Perfection; but I would however wish, that no more faults were imputed to me than what are really my own.

THE

022

THE
ANATOMY
OF THE
HUMAN NERVES.

Of the NERVES in general.

1. **T**HE numerous turns which the *carotid* and *vertebral* arteries make before they pass through the *dura mater*, these arteries having neither swelling muscles nor pressure of the atmosphere to assist the course of the blood in them after they enter the scull, and their division into innumerable communicating branches in the *pia mater*, and its processes, shew, that the liquors must move more slowly and equally in them than in most other parts of the body.

2. By the assistance of injections and microscopes, the very minute branches of these vessels (§ 1.) are discovered to go from the *pia mater* into the *cortex*, *cineritious*, or *ashy-coloured* part of the *cerebrum*, *cerebellum*, and *spinal marrow*; whereas we can only see longitudinal vessels, without numerous ramifications or reticular plexuses, in the white medullary substance of these parts.

3. The continuity of the *cortex* with the *medulla* of the *encephalon* and *spinal marrow* is observable with the naked eye, and is more distinctly seen with the assistance of a microscope.

4. In

4. In dissecting the *brain* and *cerebellum*, we see the small beginnings of the *medulla* proceeding from the *cortex*, and can trace its gradual increase by the addition of more such white substance coming from the *cortex*.

5. Both these substances (§ 4.) are very succulent; for, being exposed to the air to dry, they lose more of their weight than most other parts of the body do.

6. In several places we can observe the *medulla* to be composed of fibres laid at each others sides.

7. The medullary substance is employed in forming the white fibrous cords, which have now the name of *nerves* appropriated to them. Within the scull we see the nerves to be the medullary substance continued; and the *spinal marrow* is all employed in forming nerves.

8. The common opinion concerning the rise of the nerves, founded on a superficial inspection of those parts, is, that the nerves are propagated from that side of the *encephalon*, at which they go out of the scull. But it having been remarked, after a more strict inquiry, and preparing the parts by maceration in water, that the medullary fibres decussate or cross each other in some parts of the *medulla*; as for example, at the *corpus annulare*, and beginning of the *spinal marrow*: And practical observers having related several examples of people whose brain was hurt on one side, while the morbid symptom, palsy, appeared on the other side of the body, of which I have seen some instances; and experiments made on brutes having confirmed these observations, it has been thought, that the nerves had their rise from that side of the *encephalon*, which is opposite to their egress from the scull. It may however still be said, that this last opinion is not fully demonstrated, because a decussation in some parts is not a proof that it obtains universally; and if there are examples of palsy of the side opposite to where the lesion of the brain was, there are also others, where the injury done to the brain and the palsy were both on the same side.

9. The

9. The nerves are composed of a great many threads lying parallel to each other, or nearly so, at their exit from the *medulla*.

This fibrous texture is evident at the origin of most of the nerves within the scull; and in the *cauda equina* of the *spinal marrow*, we can divide them into such small threads, that a very good eye can scarce perceive them; but these threads, when looked at with a microscope, appear each to be composed of a great number of smaller threads.

10. How small one of these fibrils of the nerves is, we know not; but when we consider that every, even the most minute part of the body is sensible, and that this must depend on the nerves (which all conjoined, would not make a cord of an inch diameter) being divided into branches or filaments to be dispersed through all these minute parts, we must be convinced that the nervous fibrils are very small. From the examination of the *minimum visibile*, it is demonstrated, that each fibre in the *retina* of the eye or expanded optic nerve, cannot exceed the size of the $\frac{1}{32,400}$ part of a hair.

11. The medullary substance, of which the nervous fibrils are composed, is very tender, and would not be able to resist such forces as the nerves are exposed to within the bones, nor even the common force of the circulating fluids, were not the *pia mater*, and *tunica arachnoides* continued upon them; the former giving them firmness and strength, and the latter furnishing a cellular coat to connect the threads of the nerves, to let them lie soft and moist, and to support the vessels which go with them.

It is this cellular substance that is distended when air is forced through a blow-pipe thrust into a nerve, and that makes a nerve appear all spongy, after being distended with air till it dries; the proper nervous fibrils shrivelling so in drying, that they scarce can be observed.

12. These coats (§ 11.) would not make the nerves strong enough to bear the stretching and pressure they are

are exposed to in their course to the different parts of the body; and therefore, where the nerves go out at the holes in the *cranium* and *spine*, the *dura mater* is generally wrapt closely round them, to collect their disengaged fibres into tight firm cords; and, that the tension which they may happen to be exposed to, may not injure them before they have got this additional coat, it is firmly fixed to the sides of the holes in the bones through which they pass.

13. The nervous cords thus composed of nervous fibrils, cellular coat, *pia* and *dura mater*, have such numerous blood-vessels, that after their arteries only are injected, the whole cord is tinged of the colour of the injected liquor; and if the injection is pushed violently, the cellular substance of the nerves is at last distended with it.

14. A nervous cord, such as has been just now described, (§ 13.), has very little elasticity, compared with several other parts of the body. When cut out of the body, it does not become observable shorter, while the blood-vessels contract three eighths of their length.

15. Nerves are generally lodged in a cellular or fatty substance, and have their course in the interstices of muscles, and other active organs, where they are guarded from pressure; but in several parts they are so placed, as if it was intended that they should there suffer the vibrating force of arteries, or the pressure of the contracting fibres of muscles.

16. The larger cords of the nerves divide into branches as they go off to the different parts; the branches being smaller than the trunk from which they come, and making generally an acute angle where they separate.

17. In several places, different nerves unite into one cord, which is commonly larger than any of the nerves which form it.

18. Several nerves, particularly those which are distributed to the bowels, after such union, (§ 17.), suddenly form a hard knot considerably larger than all

all the nerves of which it is made. These knots were called *corpora olivaria*, and are now generally named *ganglions*.

19. The *ganglions* have thicker coats, more numerous, and larger blood-vessels than the nerves; so that they appear more red and muscular. On dissecting the *ganglions*, fibres are seen running longitudinally in their axes, and other fibres are derived from their sides in an oblique direction to the longitudinal ones.

20. Commonly numerous small nerves, which conjunctly are not equal to the size of the *ganglion*, are sent out from it, but with a structure no way different from that of other nerves.

21. The nerves sent to the organs of the senses, lose there their firm coats, and terminate in a pulpy substance. The *optic nerves* are expanded into the soft tender webs, the *retinæ*. The *auditory nerve* has scarce the consistence of *mucus* in the *vestibulum*, *cochlea*, and *semicircular canals* of each ear. The *papille* of the nose, tongue, and skin, are very soft.

22. The nerves of muscles can likeways be traced till they seem to lose their coats by becoming very soft; from which, and what we observed of the sensory nerves (§ 21.), there is reason to conclude, that the muscular nerves are also pulpy at their terminations, which we cannot indeed prosecute by dissection.

23. It would seem necessary that the extremities of the nerves should continue in this soft flexible state, (§ 21. 22.), in order to perform their functions right: For, in proportion as parts become rigid and firm by age, or any other cause, they lose of their sensibility, and the motions are more difficultly performed.

24. Though the fibres in a nervous cord are firmly connected, and frequently different nerves join into one trunk, or into the same *ganglion*; yet the sensation of each part of the body is so very distinct, and we have so much the power of moving the muscles separately, that, if the nerves are principal agents in these two functions, which I shall endeavour to prove they are, we have reason to believe that there

is no union, confusion, or immediate communication of the proper nervous fibrils, but that each fibre remains distinct from its origin to its termination.

25. Changes produced any way upon the coats of the nerves, cannot however miss to affect the nervous fibrils. The cellular substance may be too full of liquor, or may not supply enough; the liquor may not be of a due consistence, or it may be preternaturally obstructed and collected. The *pia* or *dura mater*, may be too tense, or too lax; their vessels may be obstructed; their proper nerves may be violently irritated, or lose their power of acting; and a great many other such changes may happen, which will not only occasion disorders in particular nerves, but may be a cause of the *sympathy* so frequently observed among the nerves; which is so necessary to be attentively regarded in a great many diseases, in order to discover their true state and nature, that, without this knowledge, very dangerous mistakes in the practice of physic and surgery may be committed.

26. Many experiments and observations concur in proving, that when nerves are compressed, cut, or any other way destroyed, the parts served by such nerves, farther from the head or spine than where the injuring cause has been applied, have their sensations, motions, and nourishment weakened or lost, while no such effects are seen in the parts nearer to the origin of those nerves; and in such experiments where the cause impeding the nerves to exert themselves could be removed, and the structure of the nerves not injured, as for example, when a ligature made upon a nerve, and stopping its influence, has been taken away, the motion and sensation of the parts soon were restored. From which it would appear, that the nerves are principal instruments in our sensations, motions, and nourishment; and that this influence of the nerves is not inherent in them, without the communication between these cords and their origin is preserved.

This

This conclusion is just, notwithstanding that sometimes, upon cutting a nerve, the effects above mentioned have been felt for a short time; but afterwards the person was sensible of no numbness or immobility; for where-ever this is said to have happened, the cut nerve was only one of several which were sent to the member; the want of whose influence was felt no longer, than till the habit was acquired of performing the functions easily by the other nerves.

Nor is it of greater weight as an objection, that sometimes when a ligature is drawn very hard upon a nerve, and then is taken away, the nerve never again recovers its influence upon the parts it is distributed to beyond the ligature, but is of as little effect as if it had been cut through; which is to say, that its texture has been altered beyond recovery. The same thing is to be seen by tying a thread tight round a tender twig of any vegetable; it decays.

27. Experiments and observations shew too, that when parts of the *encephalon* or *spinal marrow* have been irritated, compressed, or destroyed, the parts of the body, whose nerves had their origin from such affected parts of the *encephalon* or *spinal marrow*, become convulsed, paralytic, insensible, or wasted; and in such cases where the injuring cause could be removed from the origin of the nerves, the morbid symptoms observed in the parts to which these nerves were distributed, went off upon the removal of that cause. From which it is thought reasonable to conclude, that the nerves must not only have a communication with their origin, but that the influence they have upon the parts they are distributed to, depends on the influence which they derive from the *medulla encephali* and *spinalis*.

28. Though the *spinal marrow* has its own vessels and cineritious substance which assists to form its *medulla*; yet a very large share of the medullary substance within the spine is derived from the *encephalon*, whose *medulla oblongata* descends from the head, and the influence of the *spinal marrow* on its nerves de-

pends in a great measure on this *medulla oblongata* of the head. Hence an injury done to any part of the *spinal marrow*, immediately affects all the parts whose nerves have their origin below where the injuring cause is applied. A luxation of a *vertebra* in the loins makes the lower extremities soon paralytic; a transverse section of the *medulla* at the first *vertebra* of the neck, soon puts an end to life.

29. If such causes produce constantly such effects (§ 26. 27. 28.) in us and other creatures living in nearly the same circumstances as we do, the conclusions already made must be good, notwithstanding examples of children and other creatures being born without *brains* or *spinal marrow*; or notwithstanding that the brains of adult creatures can be much changed in their texture by diseases; and that *tortoises*, and some other animals, continue to move a considerable time after their heads are cut off. We may be ignorant of the particular circumstances requisite or necessary to the being or well-being of this or that particular creature, and we may be unable to account for a great many *phænomena*; but we must believe our eyes in the examination of facts; and if we see constantly such consequences from such actions, we cannot but conclude the one to be the cause, and the other the effect. It would be as unjust to deny the conclusions made in the three preceding articles, because of the seemingly preternatural *phænomena*, mentioned at the beginning of this, as it would be to deny the necessity of the circulation of the blood in us and most quadrupeds, because a frog can jump about, or a tortoise can walk long after all the bowels of its thorax and abdomen are taken out, or because the different parts of a worm crawl after it has been cut into a great many pieces. It is therefore almost universally allowed, that the *nerves* are *principal instruments* in our sensations, motion, and nourishment; and that the influence which they have is communicated from their origin, the *encephalon* and *medulla spinalis*. But authors are far from agreeing about

bout the manner in which this influence is communicated, or in what way nerves act to produce these effects.

30. Some alledge, that the nervous fibres are all solid cords acting by elasticity or vibration; others maintain, that those fibres are small pipes conveying liquors, by means of which their effects are produced.

31. The gentlemen, who think the nervous fibres solid, raise several objections to the other doctrine; which I shall consider afterwards; and endeavour to shew the fitness of their own doctrine to account for the effects commonly observed to be produced by the nerves.

The objects of the senses plainly (say they) make impulses on the nerves of the proper organs, which must shake the nervous fibrils; and this vibration must be propagated along the whole cord to its other extremity or origin; as happens in other tense strings; and these vibrations being differently modified, according to the difference of the object, and its different application, produce the different ideas we have of objects.

32. To this account of sensation, it is objected, first, That nerves are unfit for vibrations, because their extremities, where objects are applied to them, are quite soft and pappy (§ 21.), and therefore not susceptible of the vibrations supposed; and if there could be any little tremor made here by the impulse of objects, it could not be continued along the nervous cord, because the cellular substance by which each particular fibre is connected to the neighbouring ones (§ 11.), and the fatty substance in which the nervous cord is immersed (§ 15.), would soon stifle any such vibratory motion.

A second objection to this doctrine is, that supposing the nerves capable of vibrations by the impressions of objects, these vibrations would not answer the design. For if what we know of other vibrating strings, to wit, that their tone remains the same, unless their texture, length, or tension is altered, and that diffe-

rent substances striking them do no more than make the sound higher or lower ; if these properties are to be applied to nerves, then it will follow, that the same nerve would constantly convey the same idea, with no other variety than of its being weaker and stronger, whatever different objects were applied to it ; unless we supposed the nerve changed in its texture, length, or tension, each time a different object is applied ; which, it is presumed, no body will undertake to prove does happen.

Nay, 3dly, If ever such a variety of vibrations could be made, our sensations would notwithstanding be confused and indistinct, because the tremulous nervous fibre being firmly connected and contiguous to several other fibres of the same cord, would necessarily shake them too, by which we should have the notion of the object as applied at all the different parts where the extremities of these fibres terminate.

33. In whatever way the favourers of the doctrine of solid nerves please to apply the elasticity of nerves to the contraction of muscles, their adversaries insist that nerves are too weak to resist such weights as the muscles sustain ; they would surely break, especially as they are in a great measure, if not wholly, deprived of their strong coats before they come to the part of the muscle they are immediately to act upon (§ 22.)—The nerves being found to have little or no elasticity to shorten themselves (§ 14.), shews them altogether unfit for such an office as this of contracting muscles in the way proposed of their acting by elasticity ; and when a nerve is viewed with a microscope while the muscles it serves are in action, no contraction or motion is observed in it.—Nay, if they were elastic, they would equally exert their power of contracting muscles nearer to their origin as well as farther from it, when they were put into contraction or vibration, by irritation of any part of them. The former however does not happen.

34. As a farther objection against either motion or sensation being owing to the elasticity of the nerves,

it is said, that if this doctrine was true, the sensations would be more acute, and the contractions of muscles would be greater and stronger, when the parts become firmer and more rigid by age; for then their elasticity is increased: Whereas, on the contrary, it appears (§ 23.) that then the sensations are blunted, and muscular contraction becomes less and weaker.

35. If the nerves were granted to be elastic, and to communicate a springy force to all the parts they are distributed to, they might appear necessary in this view to assist the application of the nutritious particles of the fluids to the sides of the vessels which these particles were to repair; and so far might well enough account for the share which nerves are thought to have in nutrition: But if we cannot make use of elasticity in the other two functions, sensation and motion, we must also endeavour to find out some other way for the nerves to act in nutrition; which will be done afterwards.

36. Having thus stated the reasons for and against the nerves acting as solid strings, let us likewise relate the arguments for nerves being pipes, and the objections to this doctrine.

A great argument of those who think the nerves to be tubes conveying liquors, is the strong analogy of the brain and nerves to other glands of the body and their excretaries, where a manifest secretion of liquor is made in the glands, to be conveyed by the excretaries to the proper places in which it ought to be deposited: They think that the vascular texture of the cortex of the *encephalon* and *spinal marrow* (§ 2.), the continuation of the cortex in forming the medullary substance (§ 3. 4.), the fibrous texture (§ 6.), and succulent state of this *medulla* (§ 5.), and its being wholly employed to form the nerves (§ 7.), where the fibrous texture is evident (§ 9.); all these things, say they, conspire to shew such a strong analogy between these parts and the other glands of the body, as carries a conviction that there is a liquor secreted in the *encephalon*.

encephalon and *spinal marrow*, to be sent out by the nerves to the different parts of the body.

37. The following objections are raised to this argument in favour of liquor conveyed in the nerves, from the analogy of the glands. *1st*, Other glands, it is said, have their excretaries collected into a few large pipes, and not continued in such a great number of separate pipes, as far as the places where the liquors are deposited; which last must be the case, if the nerves are the excretaries of the glandular brain. *2dly*, We see the cavities, and can examine the liquors in the excretaries of other glands much smaller than the brain; which cannot be done in the nerves. *3dly*, If the nerves were pipes, they would be so small, that the attraction of the liquors to their sides, would prevent that celerity in the motion of the liquors, which is requisite to sensations and motions. *4thly*, If the nerves were pipes, they would be cylindrical ones, and consequently not subject to diseases; or at least we could have no comprehension of the diseases in them.

38. The answer to the *1st* of these objections is, That there are other glands where there is a manifest secretion, and in which the disposition of the excretaries is in much the same way as is in the *encephalon*: The kidneys, for example, have a reticulated *cortex* of vessels, from which the *Eustachian* or *Bellinian medulla*, consisting of longitudinal fibres and a few blood-vessels in the same direction, proceeds; and this *medulla* is collected into ten, twelve, or more *papillæ*, each of which is formed of numerous small separate pipes, which singly discharge the urine into the large membranous tubes; and these united form the *pelvis*. Upon comparing this texture of the kidneys with that of the *encephalon* (§ 2. 3. 4. 5. 6. 7. 9.) the analogy will be found very strong.

39. In answer to the *2d* objection, in § 37. it is granted, that microscopes, injections, and all the other arts hitherto employed, have not shewn the cavities of the nervous fibrils, or the liquors contained in

in them; and from what was said (§ 10.) of the smallness of the nervous fibrils, it is not to be expected that ever they should be seen. But so long as such a number of little animals can every hour be brought to the objectors, in which they can as little demonstrate the vessels or contained fluids, it will not be allowed to be conclusive reasoning, that because ocular demonstration cannot be given of either the tubes or their contents, therefore they do not exist. For if we have any notion of an animal, it is its being an hydraulic machine, which has liquors moving in it as long as it has life; if therefore such little animals have vessels and liquors which we cannot see, why may not some of the vessels and liquors of the human body be also invisible to us?

To avoid this answer to the objection, it is further urged, That though we might not see the nervous tubes or the liquors they contain, as they naturally flow; yet if such liquors really exist, they ought to discover themselves, either by a nerve's swelling when it is firmly tied; or that, however subtle their fluids are, they might be collected in some drops, at least, when the cut end of a nerve of a living animal is kept some time in the exhausted receiver of an air-pump. It is affirmed, that neither did the tied nerve swell between the brain and ligature, nor was there any liquor collected in the receiver of the air-pump; from which it is concluded, that there is no liquor in the nerves.

Some, who say they have tried these experiments, affirm, that, in young animals, the nerve does swell above the ligature, and that a liquor does drill out upon cutting a nerve.—Whether swelling or liquor is seen or is not seen in these experiments, no conclusion for or against a nervous fluid can be made from them; for the swelling of the nerve after it is tied, or the efflux of liquors from its extremity, will never prove either to be the effect of the fluid in the proper nervous fibrils, so long as they might be occasioned by the liquors in the larger vessels of the cellular

cellular substance of the nerves; and if these same vessels of the coats of the nerves do not discover their liquors by these experiments, it is far less to be expected, that the much more subtle nerves will discover theirs.

40. The 3d objection to the doctrine of the brain being a gland, and the nerves its excretaries, supposes a more rapid motion necessary in the fluid of the nerves, than what most of the defenders of the nervous fluid will now allow; and is afterwards to be considered particularly in a more proper place.

41. The 4th objection being, That if nerves are excretaries of a gland, they must be cylindrical pipes, in which no obstructions or diseases would happen; but since we daily see diseases in the nerves, they must therefore not be such excretaries. The answer is, That diseases happen often in the excretaries of other glands, as of the liver, kidneys, &c. notwithstanding their cylindrical form, and their much shorter and less exposed course. When we consider the very tender substance of the brain, the vast complication of vessels there, the prodigious smallness of the pipes going out from it, the many moving powers which the nerves are to undergo the shock of, and the many chances which the vessels, membranes, and cellular substance accompanying the nerves have of being disordered, and then affecting the nervous fibrils, we have very great reason to be surprised, that these cylindrical pipes are not much more frequently put out of order, by too great or too small a quantity of liquors; by two viscid or too thin fluids; by liquors consisting of too mild and sluggish particles, or of too acrid pungent ones; by too great or too little motion given to the liquors; by the diameters of the pipes being too much straitened, or too much enlarged; and ~~but~~ ⁱⁿ great many other varieties of circumstances which might be thought capable of disturbing the functions of the nerves, supposing them to be cylindrical excretaries of the gland, the brain.

42. The

42. The numerous vessels of the *encephalon* have brought some of the gentlemen who assert the nerves to be solid, to acknowledge, that there is a liquor secreted in the brain: But then they will not allow that this liquor is sent out by the proper nervous fibrils; but that it is poured into the cellular substance in which the nerves lie, to keep them moist and supple, and therefore fit for exerting their elasticity, vibration, &c. by which, in their opinion, the effects commonly ascribed to nerves are produced.

43. Besides the objections already mentioned (§ 32. 33.) against the nerves acting as elastic strings, this opinion has some other difficulties which may be objected to it: For instance, there is not one analogous example in the whole body of liquors secreted in a large gland, to be poured into a cellular substance, as is here supposed; the liquors in the cells of the *tela cellularis* of other parts are separated from the little arteries which are distributed to these cells.

Further, it cannot be imagined, how a liquor secreted in the *cortex* of the brain should make its way through the *medulla*, to come out into the cellular membranes on the surface of that *medulla*.

Lastly, A very simple experiment, of injecting water by the artery of any member, and thereby filling the cellular substance of the nerves of that member, shews evidently, that the liquor of the cellular substance of the nerves has the same fountain as the liquor has in the *tela cellularis* any where else, that is, from the little arteries dispersed upon it.

44. The doctrine of a fluid in the nerves, is not only thus supported by the analogy of the brain and nerves to the other glands and their excretaries, but those who maintain this doctrine mention an experiment which they think directly proves a fluid in the nerves. It is this: After opening the thorax of a living dog, catch hold of and press one or both the *phrenic* nerves with the fingers, the *diaphragm* immediately ceases to contract; cease to compress the nerves, and the muscle acts again: A second time, lay

lay hold of the nerve or nerves some way above the *diaphragm*, its motion stops. Keep firm the hold of the nerve, and, with the fingers of the other hand, strip it down from the fingers which make the compression towards the *diaphragm*, and it again contracts : A repetition of this part of the experiment three or four times, is always attended with the same effects ; but it then contracts no more, strip as you will, unless you remove the pressure, to take hold of the nerves above the place first pinched ; when the muscle may again be made to contract, by stripping the nerve down towards it. This experiment I have done with the success here mentioned. Let any one try if he can imagine any other reasonable account of these appearances, than that the pressure by the fingers stopped the course of a fluid in the nerve, betwixt the fingers and *diaphragm* was forced into that muscle by stripping, and when it was all pressed away, the fingers above preventing a supply, the muscle contracted no more till the fingers were removed, and a fresh flow by that means was received from the spinal marrow, or from that part of the nerve which had yet not been so stripped.

It has been objected to the conclusions from this experiment, 1. That the *diaphragm* is set in motion by stripping the nerve from, as well as towards this muscle ; and this may be well expected ; for a liquor in such small pipes hindered to flow backwards by ligature, pinching fingers, or even the flow of their liquors from the fountain, will regurgitate forwards with velocity, when pressed backwards. We see it happen in the stalks of tender succulent plants.

2. It is said, that muscles cease to act when their veins are tied, as well as when their arteries or nerves are tied or cut, but that muscles continue to act when their veins are cut ; by which it would appear, that the overloading of the vessels is an impediment to the action of muscles, and therefore the ceasing of their action,

action, when their arteries or nerves are tied or cut, may also be owing to the liquor in the branches of these pipes of muscles stagnating when it is not propelled by the flow of more liquor from their trunks, and not to any influence or moving power, which now ceases to be conveyed to them.

It is to be observed in making the experiments just now mentioned, that the contraction of the muscles ceases soonest when the nerves, and latest when the veins are tied.—That when veins are tied, not only are the vessels overloaded, but all the cellular substance of the muscles is filled with coagulated blood; whereas when the arteries and nerves are tied, the reverse is seen, the muscles are lax and of less bulk. So that in these cases, the ceasing of the contraction of the muscles seems to depend on very different causes, to wit, a deprivation of necessary liquors in the one, and a redundancy of superfluous blood in the other. An elastic stick may be deprived of its elasticity by being made either too dry or too wet.

45. Some gentlemen, convinced of the reasonableness of the secretion of a liquor in the brain to be sent out by the nerves, but not comprehending how a fluid could have such a rapid retrograde motion as they imagined was necessary for conveying the impressions of objects made on the extremities of nerves to the *sensorium*, supposed two sorts of nerves; one that conveyed a liquor for muscular motion and nutrition; the other composed of solid nerves, that were to serve for organs of the senses, to convey the vibrations communicated from objects to the *sensorium*.

46. To this opinion (§ 45.) the objections against the sensatory nerves acting by vibration (§ 32.) may be made; and there is so little reason to suspect any difference in the texture of the different parts of the brain or nerves, that, on the contrary, the structure is every where similar, and branches of the same nerve often serve both for sensation and motion.

How little necessity there is for supposing extremely rapid motions of the nervous fluid, is to be examined soon.

47. The hypothesis of great celerity in the motion of the fluid of the nerves being necessary, gave also rise to another division of the nerves, into *arterious* or *effluent*, and *venous* or *refluous*. It was said, that muscular motion and nutrition depended on the arterious nerves; and that the sensations depended on an accelerated motion of the nervous fluid towards the brain, by the impressions which the objects of the senses make upon the venous nerves. By this supposition the absurdity of rapid fluxes and refluxes in the same canal was prevented, and an advantage was thought to be gained by it, of saving too great a waste of the fluid of the nerves, which otherwise the *encephalon* and *spinal marrow* could not supply in sufficient quantity to answer all the exigencies of life.

48. To this opinion (§ 47.) it has been objected, 1st, That there is no example in the body, of a secreted liquor being returned immediately and unmixed to the gland by which it was originally separated from the mass of blood; which would be the case, were there venous nerves. 2^{dly}, There is no occasion for saving the fluid of the nerves in the way proposed; the organs for secreting that fluid being large enough to supply all that is necessary of it in the common functions of life.—3^{dly}, If the fluid of the nerves was to be thus kept in a perpetual circulation, it would soon become too acrid for continuing with safety in such sensible tender vessels as the brain and nerves are composed of. 4^{thly}, This hypothesis will not answer the design for which it was proposed: For though the momentary application of an object might cause an acceleration in the fluid of venous nerves, yet if the object was kept applied to the nerves, it would stop their fluid, so that it could not go forward to the brain; and therefore, according to this doctrine, we should be sensible of no objects, except

except those whose application to the organs of the senses was momentary.

49. Let us now suppose it probable, that the *encephalon* and *spinal marrow* secern a liquor from the blood which is sent into all the nerves, and that by the means of this liquor, the nerves perform the offices commonly assigned to them; it is next necessary to enquire what kind of liquor this is, and how it moves, in order to determine how well its nature and motion are fitted for performing what is expected from it.

50. The liquor of the nerves has been fancied by some to be of a very strong acid or alcaline nature: But since none of our juices appear to be of this sort, and since such liquors irritate and destroy the parts of the body which they are applied to, we cannot conceive how the brain can separate, or the nerves could bear any thing of such an acrid nature. This tenderness and sensibility of these organs must hinder us absolutely from supposing that the liquor of the nerves can be acrid or pungent, or of the nature of spirit of wine, hartshorn, &c.

51. Some have imagined the liquor of the nerves to be capable of vast explosion like gun-powder, or of violent sudden rarefaction like air, or of strong ebullition like boiling water, or the mixture of acids with alcaline liquors. But as the mass of blood from which this fluid is derived, is not possessed of any such properties, we cannot suppose the blood to furnish what it has not in itself. Besides, all these operations are too violent for the brain or nerves to bear; and when once they are begun, they are not so quickly controlled or restrained, as experience teaches us the nerves can be made to cease from acting.

52. We are not sufficiently acquainted with the properties of an *aether* or *electrical effluvia* pervading every thing, to apply them justly in the animal economy; and it is as difficult to conceive how they should be retained or conducted in a long nervous cord. These are difficulties not to be surmounted.

53. The surest way of judging what kind of liquor this of the nerves must be, is to examine the liquors of similar parts of the body. All the glands separate liquors from the blood much thinner than the compound mass itself; such is the liquor poured into the cavity of the *abdomen*, *thorax*, *ventricles of the brain*, the *saliva*, *pancreatic juice*, *lymph*, &c. Wherever there is occasion for secreted liquors being thick and viscid, in order to answer better the uses they are intended for, nature has provided reservoirs for them to stagnate in, where their thinner parts may be carried off by the numerous absorbent veins dispersed on the sides of those cavities; or they may exhale where they are exposed to the open air. The *mucus of the nose* becomes viscid by stagnation; for, when it is immediately secreted it is thin and watery; as appears from the application of sternutatories, &c. The *cerumen of the ears* is of a watery consistence, when just squeezing out. The *mucus of the alimentary canal* grows thick in the *lacunæ*. The *bile* in the hepatic duct has little more consistence than *lymph*; that in the gall-bladder is viscid and strong. The *urine* is much more watery as it flows from the kidneys, than when it is excreted from the bladder. The *seed* is thin as it comes from the testicles, and is concocted in the *vesiculae seminales*, &c.

54. Hence (§ 53.) we may safely conclude, that a thin liquor is secreted in the *cortex encephali* and *spinal marrow*; and seeing the thinness of secreted liquors is generally, as the divisions of the vessels, into small subtile branches, and that the ramifications within the scull are almost infinitely subtile, the liquor secreted in the *encephalon* may be determined to be among the finest or thinnest fluids.

55. Seeing also that we can observe no large reservoir, where the liquor secreted in the *cortical substance* is deposited, to have its finer parts taken off, we have reason to think, that it goes forward into the nerves in the same condition in which it is secreted.

56. By fine or subtle animal liquors, is meant no more than those which are very fluid, and which seem to consist of a large proportion of watery particles, and a lesser one of the oily, saline, and terrestrial particles. Some of the liquors which we can have in sufficient quantity to make experiments with, are so fluid, and have so little viscosity or cohesion of parts, that when laid upon a piece of clean mirror, they evaporate without leaving a stain; such is the liquor oozing out from the surface of the *pleura*, the lymph, and several others.

If then these liquors, which are subject to our examination, the secreting vessels of which are so large that we can see them, have such a small cohesion of parts, it might not be unreasonable to say, that the liquor of the nerves is as much more fine and fluid than lymph, as the vessels separating it are smaller; and therefore that the fluid of the nerves is a defecated water, with a very small proportion of the other principles extremely subtilized.

57. Two experiments are said to contradict this opinion, of the liquor of the nerves being so fluid and subtle. One is, that upon cutting the *cauda equina* of a living animal, a liquor as viscid as the white of an egg drops out: The other is, that a wounded nerve yields a *glairy sanies*. But these do not appear to be the proper fluid of the nerves; since it is evident, that what is discharged in both these cases, comes out of the cellular substance involving the nervous fibrils.

58. Considering how many experiments make it evident, that there is a constant uninterrupted stream of liquors flowing through all the canals of animals, which convey liquors composed of particles smaller than the diameter of their canal, which is always the case of the nerves in a natural state; it is surprising how it ever could be thought that the liquor of the nerves should be obliged to flow from the brain to each muscle the moment we will; or that this liquor should flow back with the like swiftness from

the extremity of each nerve, to which an object of sensation is applied. The nerves, as well as the other excretaries of the glands, always are full of liquor; the degree of distension of the canals not being at all times alike even in a sound state. But this happens without inconvenience, as the sides of the canals have a power to accommodate themselves to the present quantity, unless it is very much above or below the natural standard; in both which cases diseases ensue.

59. The motion of the fluid in the nerves is therefore not only constant, but it is also equal, or nearly so: For, though the blood in the larger arteries is moved unequally, by the unequal forces, the contraction of the ventricle of the heart, and the weaker power, the *systole* of the arteries; yet the difference between these two moving powers comes to be less and less perceptible, as the arteries divide into smaller branches; because of the numerous resistances which the liquors meet with, and because the canals they move in become larger, till in the very small arterious branches, there is no sensible difference in the velocity of the liquors from the effect of the heart or arteries. The motion of the fluids must still be more equal in the excretaries of glands, and particularly in those where the vessels have divided into very minute branches, and the liquors have no other propelling force but the heart and arteries, (see § 1.); therefore the nervous fluid moves constantly, equally, and slowly, unless when its course is altered by the influence of the mind, or by the pressure of some neighbouring active organ.

60. As there is neither proof nor probability of the *valves* supposed by some in nerves, we are not to assume them in accounting for any *phenomena*.

61. We have not, and perhaps cannot have any idea of the manner in which mind and body act upon each other; but if we allow that the one is affected by the other, which none deny, and that the fluid of the nerves (whatever name people please to give

give it) is a principal instrument which the mind makes use of to influence the actions of the body, or to inform itself of the impressions made on the body, we must allow that the mind can direct this instrument differently, particularly as to quantity and celerity, though we must remain ignorant of the manner how many *phenomena* depending on this connection of mind and body are produced. Thus we would in vain attempt to account for animals continuing, after their heads were struck off, or their hearts were cut out, to perform actions begun before they suffered any injury.

62. Let us now suppose the nervous fluid such as has been argued for, to wit, a very fluid saponaceous water, moving in a constant, equal, slow stream, from the *encephalon* and *spinal marrow*, in each of the proper nervous fibres, except when the motion is changed by some accessory cause, such as the mind, pressure of other parts, &c.; and let us examine how well such a supposition will agree with the *phenomena* of the three great functions, nutrition, sensation, and muscular motion, which the nerves are principal instruments of.

63. In general, we may say, that nerves can carry fluids to the most minute part of the body, to supply what is wasted in any of the solids; that the impression made by the objects of the senses on the very soft pulpy extremities of the nerves of the organs of the senses, must make such a stop in the equal-flowing nervous fluid, as must instantaneously be perceptible at the fountain head from which the pipes affected arise; that the constant flow of the liquor of the nerves into the cavities of the *muscular fibrillæ*, occasions the natural contraction of the muscles, by the as constant *nusus* it makes to increase the transverse, and to shorten the longitudinal diameter of each fibre; and that it is only to allow the mind a power of determining a greater quantity of this same fluid with a greater velocity into what muscular fibres it pleases,

to

to account for the voluntary strong action of the muscles.

64. But since such a superficial account would not be satisfactory, it will be expected, that the principal *phænomena* of these three functions should be explained by the means of such a fluid as has been supposed ; and that the several objections against this doctrine should be answered : Let us attempt this ; and where we cannot extricate ourselves from difficulties which may be thrown in, let us honestly acknowledge ignorance.

65. a. If water, with a very small proportion of oils and salts from the earth, proves a fit nourishment for vegetables, such a liquor as the fluid of the nerves has been described (§ 56.) may not be unfit for repairing the waste in animals.

b. The slow continual motion of this nervous fluid (§ 58. 59.) to the most minute parts of the body (§ 10.), is well enough calculated to supply the particles that are constantly worn off from the solids by the circulation of the liquors and necessary actions of life.

c. The greater proportional size of the *encephalon* in young creatures than in adults, seems calculated for their greater proportional growth : For the younger the animal is, the larger *encephalon* and speedier growth it has.

d. A palsy and atrophy of the members generally accompanying each other, shew, that nourishment, sensation, and motion, depend on the same cause.

e. It was said (§ 26.), that the nerves were *principal* instruments in nutrition : It was not affirmed, that they were the *sole* instruments ; and therefore an atrophy may proceed from the compression or other lesion of an artery, without being an objection to the doctrine here laid down.

66. a. All objects of sense, when applied to their proper organs, act by impulse ; and this action is capable of being increased by increasing the impelling force. In tangible objects, that is clearly evident ;
the

the closer they are pressed to a certain degree, the more distinct perception ensues. Odorous particles need the assistance of air moved rapidly, to affect our nose: Sapid substances, that are scarce sufficient to give us an idea of their taste by their own weight, are assisted by the pressure of the tongue upon the palate: The rays of light collected drive light bodies before them: Sound communicates a vibration to all bodies in harmonic proportion with it.

The impulses made thus by any of these objects on the soft pulpy nerves (§ 21.), which are full of liquor, presses their sides or extremities, and their liquor is hindered to flow so freely as it did. The canals being all full (§ 58.) this resistance must instantaneously affect the whole column of fluids in the canals that are pressed, and their origins, and have the same effect as if the impulse had been made upon the origin itself. To illustrate this by a gross comparison: Let any one push water out of a syringe, through a long flexible pipe fixed to the syringe, and he is sensible of resistance or a push backwards, the moment any one stops the orifice of the pipe, or closes the sides of it with his fingers. This impulse made on the nerves, and thus communicated to their origin, varies according to the strength or weakness, the quickness or slowness, the continuance or speedy removal, the uniformity or irregularity, the constancy or alternation, &c. with which objects are applied to the nerves.

b. Whenever any object is regularly applied with due force to a nerve, rightly disposed to be impressed by it, and is communicated, as just now explained, to the *sensorium*, it gives a true and just idea of the object to the mind.

c. The various kinds of impulses which the different classes of objects make, occasion in animals, which ought to have accurate perceptions of each object, a necessity of having the different organs of the senses variously modified, so that the several impulses may be regularly applied to the nerves in each organ;

organ; or, in other words, we must have different organs of the senses fitted to the different classes of objects.

d. As the objects have one common property of impulse, so all the organs have most of the properties of the organ of touching in common with the *papillæ* of the skin. In the nose and tongue, this is evident: In some operations of the eyes we can also perceive this; as we may likewise do in some cases where matter is collected in the internal ear.

e. These properties common to the different objects and organs, occasion frequently uncommon effects in the application of an object to an organ proper to another object of sensation; for sometimes we have the same idea as if the object had been applied to its own proper organ: At other times the object is as it were changed, and we have the idea as if the organ had had its own proper object applied to it. Thus, for example, light is the proper object to be applied to the eye, to give us any idea of colours; yet when all light is excluded from the eyes, an idea of light and colours may be excited in us by coughing, sneezing, rubbing, or striking the eye-ball.—A cane vibrating, so as not to excite sound perceptible to the ear, applied to the teeth, raises a strong idea of sound; as a little insect creeping in the *meatus auditorius* also does.—The fingers applied to two rough surfaces, rubbing on each other, are sensible of the sound they make; surgeons of any practice in the cure of fractured bones can bear witness to the truth of this.—The fingers dipped in acid and several other acrid liquors, have a sensation very like to tasting.—Smelling and tasting, every body knows, are subservient and assisting to each other. From such examples we have further proof of one general cause of our sensations, to-wit, impulse from the objects; and of such a similarity and relation in the organs as might give reason for imagining that any one of them would be capable of producing the effect of another, if the impulses of the different objects could be regularly applied

plied to each.—Hence light and sound may affect insects and other animals that have not eyes or ears.

f. If the impulse of an object is applied with due force, but irregularly, a confused idea of the object is raised. Distant objects are confused to *myopes*, as very near ones are to *presbytae*.

g. If the application of the impulse is regular, but the force with which it is applied is too weak, our perception of the object is too faint. One may whisper so low as not to be heard.

b. If the application of objects is too violent, and there is any danger of the tender organs of our senses being hurt or destroyed, an uneasy sensation we call *pain* is raised, whatever the organ thus injured is. The object of feeling affects every organ: Thus pressure, stretching, cutting, pricking, acrid salts, pungent oils, great heat, violent cold, &c. occasion pain, where-ever they are applied. Besides, every particular organ can be affected with pain by the too violent application of its own proper object. Too much light pains the eyes; very loud sounds stuns the ears; very odorous bodies and too sapid objects hurt the nose and tongue. A pretty sure proof this, that the objects of our senses all act, and that the organs are all impressed, in nearly the same way.

i. Since a middle impulse, neither too small nor too great, is necessary for a clear perception of objects, we would often be in danger of not distinguishing them, if we were not subjected to another law, to wit, that numerous impulses made at once, or in a quick succession to each other, increase our perceptions of objects. Thus, such sound as would not be heard on a mountain top, will be distinctly heard in a wainscotted-chamber.—We feel much more clearly a tangible object when our finger is drawn alongst it, than when applied with the same force, but by a single pressure, upon it.—We make repeated applications of odorous and sapid objects, when we wish to smell or taste accurately.—The end of a burning stick appears

appears much more luminous when quickly whirled in a circle than when at rest.

k. Whenever the uneasy sensation, *pain*, is raised by the too strong application of objects, a sort of necessity is as it were imposed upon the mind to endeavour to get free of the injuring cause, by either withdrawing the grieved part of the body from it, as one retires his hand when his finger is pricked or burnt; or the injuring cause is endeavoured to be forced from the body, as a *tenesmus* excites the contraction which pushes acrid *faeces* out of the *rectum*. In both these operations, a convulsive contraction is immediately made in the lesed part, or in the neighbourhood of it; and if the irritation is very strong or permanent, the greater part of the nervous system becomes affected in that spasmodic or convulsive way.—Is it this necessity which obliges the mind to exert herself in respiration, or in the action of the heart, when the lungs or heart are gorged with blood? or the *iris* to contract the pupil, when the eye is exposed to strong light? or sneezing to be performed when the nose is tickled? &c.—Will not a *stimulus* of any nerve more readily affect those with which it is any where connected than the other nerves of the body?—May not this sympathy serve as a monitor of the mind rather to employ the organs furnished with nerves thus connected, to assist in freeing her of any uneasy sensation, than to make use of any other organs?—Will not this in some measure account for many salutary operations performed in the body, before experience has taught us the functions of the organs performing them?

This *nisus* of the mind to free the body of what is in danger of being hurtful, may serve to explain the *phenomena* of a great many diseases, when we are acquainted with the distribution of the particular nerves; and from this we can understand the operation of medicines that stimulate; and may learn how, by exciting a sharp, but momentary pain, we may free the body of another pain that would be more durable; and

and that, by having it thus in our power to determine a flow of the liquor of the nerves to any particular part, for the benefit of that part, or the relief of any other diseased part, we can do considerable service by a right application of the proper medicines.

1. If a pain-giving cause is very violent or long continued, it destroys the organs either irrecoverably, or puts them so much out of order that they only gradually recover: People have been made blind or deaf for all their lives after a violent effect of light on their eyes, or of sound on their ears; and we are frequently exposed to as much light and sound as to make us unfit to see or hear for a considerable time. I would explain this by a ligature put round the tender branch of an herb. This ligature drawn to a certain degree, may weaken the canals so as to be unfit for the circulation of the juices a good while, till they are gradually explicated and made firm by these juices: A stricter ligature would disorder the structure of the fibres so much, that the liquors could not recover them. The analogy is so plain, that it needs no commentary.—Thus, the influence of a nerve tied with an artery in the operation of an aneurism, may cease for some time, but be afterwards recovered.

67. 1. In applying the fluid of the nerves to the action of muscles, it was said, that the natural or involuntary contraction of muscles was the *nitus* which the nervous fluid flowing constantly into the muscular fibres makes to distend these fibrils, by enlarging their transverse diameters and shortening their axes; and that voluntary contraction was owing to a greater quantity of that nervous liquor determined towards the muscle to be put in action, and poured with greater *momentum* into the muscular fibrils, by the power of the mind willing to make such a muscle to act, or obliged to do it by an irritating pain-giving cause (§ 66. k.)

2. Some object to this account of muscular motion, that if there is no outlet for the liquor supposed to be poured into muscular fibres, muscles would always

be in a state of contraction, which they are not; and if there is a passage from the fibrils, the liquor would flow out as fast as it was thrown in; and therefore no distension of the fibres or contraction of the muscles could be made.

3. In answer to this objection, it is observed, that notwithstanding the evident outlet from the arteries into the veins, yet the arteries are distended by the *systole* of the heart, or any other cause increasing the momentum of the blood.

4. It has been also objected to § 1. That, if it was true, the volume of the muscle in contraction necessarily would be considerably increased by so much liquor poured into its fibrils; whereas it does not appear, by any experiment, that the volume of a muscle is increased by its being put into action.

5. To this it has been answered, 1. That when the axes of muscular fibres are shortened, and their transverse diameters are enlarged, the capacities of their fibres, and consequently their volume, may not be changed, the diminution one way balancing the increase in the other. 2. That the spaces between the muscular fibres are sufficient to lodge these fibres when they swell, during the contraction of a muscle, without any addition to its bulk; and that it plainly appears that these spaces between the fibrils are thus occupied, by the compression which the larger vessels of muscles, which run in those spaces, suffer during the action of the muscle; it is so great as to drive the blood in the veins with a remarkable accelerated velocity.

6. Another objection to the action of muscles being owing to the influx of a fluid into their fibrils, is, That muscular fibres are distractile, or capable of being stretched; and therefore, when a fluid is poured into their hollow fibrils, they would be stretched longitudinally, as well as have their transverse diameters increased; that is, a muscle would become longer, as well as thicker, when it is put into action; where-

as it is certainly known, that a muscle is shortened while it acts.

7. In answer to this, it has been remarked, That though muscular fibrils are distractile, yet they will not yield to, or be stretched by every force, however small, that might be applied to them. A cord that can be stretched in length by the weight of a pound or two, would not yield in the least to an ounce or two; and it must likewise be observed, that gradually as any body is stretched, its resistance to the stretching force increases. A rope may be stretched to a certain length by a pound weight appended to it, which would require two pounds to stretch it very little further; and therefore, the general observation of animal fibres being distractile, cannot be a reasonable objection to the account of muscular motion above-mentioned, unless a proof is brought that the force which the liquid of the nerves must exert upon each fibre of a muscle, in order to make it act, is capable of distracting or stretching the fibres; which has not yet been attempted to be proved.—It would appear, from the pain caused by too great an effort of muscles, especially in weak people, that muscular fibres can bear very little distraction without danger of a solution of continuity.

8. Muscles ceasing to act when their arteries are tied or cut, and being brought into motion by injecting liquors into the arteries even of a dead animal, has been mentioned as objections to the nervous influence causing their contractions.

To the first of these experiments it may be answered, That the tying or cutting of the nerves, sooner produces the effect of making the contraction cease, than stopping the influx of the arterious blood does; and it will be universally allowed, that the influx of blood into muscles is necessary for performing their functions right.

Whoever observes the motion which injecting water, or any other liquor into the arteries of a dead animal, causes in its muscles, will not compare it to

what contraction, whether voluntary or excited by irritation, he may see in a living one.

9. If muscular motion depends on the influx of the nervous liquid, the instantaneous contraction of a muscle, when the mind wills to make it act, will be easily understood from the nerves being always full of their liquor (§ 58. 66. a.)

10. If either the nerves of any muscle do not furnish a sufficient quantity of their liquor, or if the fibres of a muscle become too easily distractile, such a muscle will be inactive or paralytic.

11. If too great a quantity of the liquor of the nerves is determined to a muscle or muscles, by any cause which the mind cannot command, such muscle or muscles will be convulsed.

12. If the motion of the liquid of the nerves is not uniform, but by disease becomes irregular, an alternate relaxation and contraction of muscles may be the consequence. Hence trembling palseies, *chorea Sancti Viti*, &c. Hence also the convulsive tremors which animals have when they lose much blood.

13. Though the nerves may not furnish so much liquor as may be sufficient to make muscles contract with strength enough to overcome the resistances to their actions, yet there may be a sufficient quantity of liquor in the nerves to allow the impressions of objects to be conveyed to the *senforium*. This may be one cause of a member's being sometimes sensible after it cannot be moved.

14. Unless the liquor of the nerves acquires some energy in the brain, which we have no reason to think the circulation of the fluids in the vessels can give it, or unless it has other properties than what we can discover in it, or unless there is an agent regulating its *momentum* and course to different parts which we are not conscious of; if some of these, I say, do not obtain, the action of the heart continuing of equal force to propel our liquors, notwithstanding all the resistances that are to it, is not to be explained.

15. All muscles, but especially the heart, continue to contract in an irregular way, after they are cut away from the animal to whom they belonged; which may be owing to the liquors continuing to flow in the small vessels, and being poured irregularly into the muscular fibrillæ.

16. It is said that a muscle cut out of the body continues some time to be capable of contraction; whereas, by tying its arteries or nerves, while it is otherwise entire in the body, it loses its contracting power, which therefore does not depend on these organs, the arteries or nerves.

The loss of the power of acting, when the arteries or nerves are tied while the muscle is in the body, is denied by some who made the trial; and it might be expected, that the motion of a muscle would be more conspicuous where there is no resistance to it, as is the case when it is cut away from all the parts it is connected with, than when its connection remains, with parts resisting its contractile efforts.

17. After the heart, or any other muscle cut away from an animal, has ceased to contract, its contraction may again be restored, by breathing upon it, or pricking it with any sharp instrument. That heat or pricking should, by their *stimulus* (§ 66. k.), occasion contraction in a living creature, may be understood; but how they should have the same effect in a muscle separated from an animal, I know not.

68. Some have thought the *ganglions* of nerves (§ 18, 19, 20.) to be glandular, and to perform a secretion.—Others, from their firm texture, suppose them to be muscular, and to serve to accelerate the motion of the liquor in the nerves which proceed from them; but as no proof is offered of either of these opinions, they cannot be maintained.—Others would make them serve, 1. To divide a small nerve into many nerves, and by these means to increase the number of nervous branches. 2. To make nerves come conveniently by different directions to the parts to which they belong. 3. To reunite several small

nervous fibres into one large nerve.—Since no proof is brought that these three things cannot be done without the interposition of a *ganglion*, but, on the contrary, we see them performed where there are no *ganglions*, we must continue to acknowledge ignorance concerning the uses of these knots, the *ganglions*.

OF THE PARTICULAR NERVES.

TIS generally said, that there are forty pair of nerves in all; of which ten come out from the *encephalon*, and the other thirty have their origin from the *spinal marrow*.

Of the ten pair of nerves which come from the *encephalon*, the first is the *OLFACTORY*, which long had the name of the *mammillary processes* of the brain, because in the brutes, cows and sheep, which were most commonly dissected by the ancients, the anterior ventricles of the brain are extended forwards upon these nerves, and adhere so firmly to them, that they seem to make the upper side of the nerves. Each of them being large, where it begins to be stretched out, and gradually becoming smaller as it approaches the *cibriiform bone*, was imagined to resemble a nipple. Those who mistook the ventricles for part of the nerves, observing the cavity in them full of liquor, concluded, that these olfactory nerves served to convey the superfluous moisture of the brain to the holes of the *ethmoid bone* through which it passed into the nose. But in man, the ventricles of whose brain are not thus extended forwards, these nerves are small, long, and without any cavity, having their origin from the *corpora striata*, near the part where the internal carotid arteries are about to send off their branches to the different parts of the brain; and in their course under the anterior lobes of the brain, which have each a depression made for lodging

lodging them, the human olfactory nerves become larger, till they are extended to the cribriform bone; where they split into a great number of small filaments, to pass through the little holes in that bone; and, being joined by a branch of the fifth pair of nerves, are spread on the membrane of the nose.

The tender structure and sudden expansion of these nerves on such a large surface, render it impossible to trace them far; which has made some authors deny them to be nerves: But when we break the circumference of the *cribriform lamella*, and then gently raise it, we may see the distribution of the nerves some way on the membrane of the nose.

The contrivance of defending these long soft nerves from being too much pressed by the anterior lobes of the brain under which they lie, is singular; because they have not only the prominent orbital processes of the frontal bone to support the brain on each side, with the veins going into the longitudinal *sinus*, and other attachments bearing it up, but there is a groove formed in each lobe of the brain itself for them to lodge in.—Their splitting into so many small branches before they enter the bones of the skull, is likewise peculiar to them; for, generally, the nerves come from the brain in disengaged filaments, and unite into cords, as they are going out at the holes of the bones. This contrivance is the best for answering the purpose they are designed for, of being the organ of smelling; for, had they been expanded upon the membrane of the nose into a medullary web, such as the optic nerve forms, it would have been too sensible to bear the impressions of such objects as are applied to the nose; and a distribution in the more common way, of a cord sending off branches, would not have been equal enough for such an organ of sensation.

The 2d pair of nerves, the *OPTIC*, rising from the *thalami nervorum opticorum*, make a large curve outwards, and then run obliquely inwards and forwards, till they unite at the fore-part of the *sella Turcica*;

cica : then soon divide, and each runs obliquely forwards and outwards, to go out at its proper hole in the sphenoid bone, accompanied with the ocular artery, to be extended to the globe of the eye, within which each is expanded into a very fine cup-like web, that lines all the inside of the eye as far forwards as the *ciliary circle*, and is universally known by the name of *retina*.

Though the substance of this pair of nerves seems to be blended at the place where they are joined; yet observations of people whose optic nerves were not joined, and of others who were blind of one eye, from a fault in the optic nerve, or in those who had one of their eyes taken out, make it appear, that there is no such intimate union of substance ; the optic nerve of the affected side only being wasted, while the other was large and plump. And the same observations are contradictory to the doctrine of a decussation of all the nerves (§ 8.) ; for the disease could be traced from the affected eye to the origin of the nerve on the same side. In many fishes, indeed, the doctrine of decussation is favoured ; for their optic nerves plainly cross each other, without any union at the part where they are joined in men and most quadrupeds.

These people whose optic nerves were not joined, having neither seen objects double, nor turned their eyes different ways, is also a plain proof, that the conjunction of the optic nerves will not serve to account for either the uniform motions of our eyes, or our seeing objects single with two eyes, though it may be one cause of the remarkable sympathy of the one eye with the other in many diseases.

The *retina* of a recent eye, without any preparation, appears a very fine web, with some blood-vessels coming from its centre to be distributed on it ; but after a good injection of the arteries that run in the substance of this nerve, as is common to other nerves, it is with difficulty that we can observe its nervous medullary substance.—The situation of these vessels

vessels in the central part of the optic nerve; the want of medullary fibres here, and the firmness of this nerve before it is expanded at its entry into the ball of the eye, may be the reason why we do not see such bodies, or parts of bodies, whose picture falls on this central part of the *retina*. An inflammation in those arteries of the *retina*, which several fevers and an *ophthalmia* are generally attended with, may very well account for the tenderness in the eyes, and inability to bear the light, which people have in these diseases.—The over-distension of these vessels may likewise serve to account for the black spots observed on bright coloured bodies especially, and for that smoaky fog through which all objects are seen by people in some fevers.—If these vessels lose their tone, and remain preternaturally distended, no objects affect our *retina*, though the eye externally appears sound; or this may be one cause of an *amaurosis* or *gutta serena*.—From a partial distension of these vessels, or *paralysis* of a part of the *retina*, the central part, or the circumference, or any other part of objects, may be lost to one or both eyes.

The *THIRD PAIR* rise from the anterior part of the *processus annularis*, and, piercing the *dura mater* a little before, and to a side of the ends of the posterior clinoid process of the *sphenoid bone*, run along the *receptacula*, or *cavernous sinuses*, at the side of the *epiphrium*, to get out at the *foramina lacera*; after which, each of them divides into branches, of which one, after forming a little *ganglion*, is distributed to the globe of the eye; the others are sent to the *musculus rectus* of the *palpebra*, and to the *attollens, adductor, deprimens*, and *obliquus minor* muscles of the eye-ball. These muscles being principal instruments in the motions of the eye-lid and eye-ball, this nerve has therefore got the name of the *motor oculi*.—I have frequently observed in convulsions the eye-lids widely opened, the *cornea* turned upward and outwards, and the eye-balls sunk in the orbit; which well described the conjunct action of the muscles which

which this pair of nerves serves.—The distension of a considerable branch of the carotid, which passes over this nerve near its origin on each side, may possibly be the reason of the heaviness in the eye-lids and eyes, after drinking hard, or eating much.

The *FOURTH PAIR*, which are the smallest nerves of any, derive their origin from the back-part of the base of the *testes*; and then making a long course on the side of the annular protuberance, enter the *dura mater* a little farther back, and more externally than the third part, to run also along the *receptacula*, to pass out at the *foramina lacera*, and to be entirely spent on the *musculi trochleares*, or superior oblique muscles of the eyes. These muscles being employed in performing the rotatory motions, and the advancement of the eye-balls forward, by which several of our passions are expressed, the nerves that serve them have got the name of *PATHETICI*.—Why these small nerves should be brought so far to this muscle, when it could have been supplied easily by the *motor oculi*, I know not.

The *FIFTH PAIR* are large nerves, rising from the annular processess where the medullary processess of the *cerebellum* join in the formation of that *tuber*, to enter the *dura mater* near the point of the petrous process of the temporal bones; and then sinking close by the *receptacula* at the sides of the *sella Turcica*, each becomes in appearance thicker, and goes out of the skull in three great branches.

The first branch of the fifth is the *OPHTHALMIC*, which runs through the *foramen lacerum* to the orbit, having in its passage thither a connection with the sixth pair. It is afterwards distributed to the ball of the eye with the third, to the nose, along with the olfactory, which the branch of the fifth that passes through the *foramen orbitarium internum* joins, as was already mentioned in the description of the first pair. This ophthalmic branch likewise supplies the parts at the internal *canthus* of the orbit, the *glandula lacrymalis*, fat, membranes, muscles, and teguments.

guments of the eye-lids; its longest farthest extended branch passing through the *foramen superciliare* of the *os frontis*, to be distributed to the forehead.

The small fibres which this first branch of the fifth and the third pair of nerves send to the eye-ball, being situated on the optic nerve, and, after piercing the sclerotic coat, running along the choroid coat on the outside of the *retina* in their course to the *uvea* or *iris*, may be a cause of the sympathy between the optic nerve and the *uvea*; by which we more readily acquire the habit of contracting the *iris*, and thereby lessen the pupil, when too strong light is excluded; and, on the contrary, enlarge the pupil, when the light is too faint.—This, with the sympathy which must arise from some of the nerves of the membrane of the nostrils, being derived from this first branch of the fifth pair of nerves, may also be the cause, why an irritation of the *retina*, by too strong light, may produce sneezing, as if a *stimulus* had been applied to the membrane of the nose itself;—why pressing the internal *canthus* of the orbit, sometimes stops sneezing;—why irritation of the nose or of the eye causes the eye-lids to shut convulsively, and makes the tears to flow plentifully; and why medicines put into the nose, do often great service in diseases of the eyes.—In the megrim, all the branches of the nerve discover themselves to be affected: For the forehead is racked with pain, the eye-ball is pained, and feels as if it was squeezed, the eye-lids shut convulsively, the tears trickle down, and an uneasy heat is felt in the nose. Hence we can understand where external medicines will have the best effect, when applied to remove this disease, to wit, to the membrane of the nose, and to the forehead;—why alternate pressure near the *superciliare* hole of the frontal bone, or sneezing, sometimes gives immediate relief in the megrim;—why the sight may be lost by an injury done to the *supra-orbital* branch;—how it may be restored by agitation of that branch of this nerve.

The

The second branch of the fifth pair of nerves may be called *MAXILLARIS SUPERIOR*, from its serving principally the parts of the upper jaw. It goes out at the round hole of the sphenoid bone, and sends immediately one branch into the channel on the top of the *antrum maxillare*; the membrane of which and the upper teeth are supplied by it in its passage. As this branch is about to go out at the *foramen orbitarium externum*, it sends a nerve through the substance of the *os maxillare* to come out at *Steno's duct*, to be distributed to the fore-part of the palate; and what remains of it escaping at the *external orbital hole*, divides into a great many branches, that supply the cheek, upper lip, and nostril.—The next considerable branch of the *superior maxillary nerve*, after giving branches which are reflected through the sixth hole of the *sphenoid bone*, to join the intercostal where it is passing through the skull with the carotid artery, and the *portio dura* of the seventh pair, as it passes through the *os petrosum*, is sent into the nose by the hole common to the palate and sphenoidal bone; and the remaining part of this nerve runs in the *palato-maxillaris canal*, giving off branches to the temples and pterygoid muscles, and comes at last into the palate to be lost.—Hence, the ache in the teeth of the upper jaw occasions a gnawing pain, deep-seated in the bones of the face, with swelling in the eye-lids, cheek, nose, and upper lip; and, on the other hand, an inflammation in these parts, or a megrim, is often attended with sharp pain in the teeth.—Hence, an obstruction in the duct of the maxillary sinus, which obliges the liquor secreted there to find out a preternatural route for itself, may be occasioned by the pain of the teeth.—Hence, the upper lip often suffers when the palate or nose is ulcerated.

The third or *MAXILLARIS INFERIOR* branch of the fifth pair going out at the oval hole of the sphenoid bone, serves the muscles of the lower jaw, and the muscles situated between the *os hyoides* and *jaw*:

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jaw: All the salivary glands, the *amygdala*, and the external ear, have branches from it: It has a large branch lost in the tongue, and sends another through the canal in the substance of the lower jaw to serve all the teeth there, and to come out at the hole in the fore-part of the jaw, to be lost in the chin and under-lip.—Hence, a convulsive contraction of the muscles of the lower jaw, or the mouth's being involuntarily shut, a great flow of spittle or salivation, a pain in the ear, especially in deglutition, and a swelling all about the throat, are natural consequences of a violent irritation of the nerves of the lower teeth in the tooth-ach; and pain in the teeth and ear, is as natural a consequence of an *angina*.—Hence, alternate pressure on the chin may sometimes relieve the violence of a tooth-ach.—Hence, destroying the nerves of a tooth by actual or potential cauteries, or pulling a carious tooth, so often removes immediately all these symptoms.—Hence, no cure is to be found for some ulcers in the upper or lower jaw, but by drawing a tooth.—Hence, in cancers of the upper lip, the salivary glands are in danger of being affected, or the disease may be occasioned to the lip by its beginning in the glands.—Perhaps the sympathy of the organs of tasting and smelling may, in some measure, depend on their both receiving nerves from the fifth pair.

The *SIXTH PAIR*, which is the smallest except the fourth, rises from the fore-part of the *corpora pyramidata*; and each entering the *dura mater* some way behind the posterior clinoid process of the sphenoid bone, has a long course below that membrane, and within the *receptaculum* at the side of the *sella Turcica*, where it is immersed in the blood of the receptacle; but for what purpose I am ignorant. It goes afterwards out at the *foramen lacerum* into the orbit, to serve the *abductor* muscle of the eye.—A defect in this nerve may therefore be one cause of a *strabismus*.—In the passage of this nerve below the *dura mater*, it lies very contiguous to the internal carotid

rotid artery, and to the ophthalmic branch of the fifth pair of nerves. At the place where the sixth pair is contiguous to the carotid, a nerve either goes from each of them in an uncommon way, to wit, with the angle beyond where it rises obtuse, to descend with the artery, and to form the beginning of the intercostal nerve, according to the common description; or, according to other authors, this nerve comes up from the great *ganglion* of the *intercostal*, to be joined to the sixth here.

The arguments for this latter opinion are, That, according to the common doctrine, this beginning of the *intercostal* nerve, as it is called, would rise in a manner not so ordinary in nerves. In the next place, it is observed, that the sixth pair is larger nearer to the orbit, than it is before it comes to the place where this nerve is said to go off; and therefore, it is more probable, that it receives an addition there, rather than gives off a branch. *Lastly*, It is found, that upon cutting the *intercostal* nerves of living animals, the eyes plainly were affected; they lost their bright water; the gum, or gore, as we call it, was separated in greater quantity; the pupil was more contracted; the cartilaginous membrane, at the internal *canthus*, came more over the eye; and the eyeball itself was diminished.

To this it is answered, in defence of the more common doctrine, 1st, That other branches of nerves go off in a reflected way, as well as this does, supposing it to be the beginning of the intercostal; and that the reflection would rather be greater, if it is thought to come up from the intercostal to the sixth. 2^{dly}, It is denied that this nerve is for ordinary thicker at its fore than its back part; and if it was supposed to be thickest nearer to the orbit, the conclusion made above could not be drawn from this appearance, because other nerves enlarge sometimes where there is no addition made to them, as in the instance already mentioned of the trunk of the fifth pair while below the *dura mater*. 3^{dly}, The experiments on

living

living animals shew indeed, that the eyes are affected, upon cutting the intercostal nerve, but not in the way which might have been expected, if the *intercostal* had furnished such a share of the nerve that goes to the *adductor* muscle of the eye; for it might have been thought, that this muscle would have been so much weakened immediately upon cutting the *intercostal*, that its antagonist the *adductor* would have greatly prevailed over it, and have turned the eye strongly in towards the nose; which is not said to be a consequence of this experiment. So that the arguments are still equivocal; and more observations and experiments must be made, before it can be determined with certainty, whether the fifth pair gives or receives a branch here. In the mean time, I shall continue to speak about the origin of the *intercostal* with the generality of anatomists.

At this place where the *intercostal* begins, the fifth pair is contiguous and adherent to the sixth; and it is generally said, that the ophthalmic branch of the fifth gives a branch or two to the beginning of the *intercostal*, or receives such from it. Others deny any such communication between them; and those who affirm the communication confess, that in some subjects they could not see it. After examining the nerves here in a great many subjects, I cannot determine whether or not there are nervous filaments going from the one to the other. Sometimes I have thought that I traced them evidently; at other times I observed, that what I dissected for nervous filaments was collapsed cellular substance; and in all the subjects where I had pushed an injection successfully into the very small arteries, I could only observe a *plexus* of vessels connecting the one to the other. In any of these ways, however, there is as much connection as, we are assured from many experiments and observations on other nerves, is sufficient to make a very great sympathy among the nerves here. Possibly the appearances in the eyes of dogs, whose *intercostal* nerves were cut, might be owing to this sympathy.

The *SEVENTH PAIR* comes out from the lateral part of the *annular process*, behind where the medullary process of the *cerebellum* are joined to that *tuber*; and each being accompanied with a larger artery than most other nerves, enters the *internal meatus auditorius*, where the two large bundles of fibres, of which it appeared to consist within the scull, soon separate from each other; one of them entering by several small holes into the *vestibule*, *cochlea*, and *semicircular canals*, is stretched on this inner *camera* of the ear in a very soft pulpy substance; and being never seen in the form of a firm cord, such as the other parcel of this and most other nerves become, is called *PORTIO MOLLIS* of the auditory nerve.

The other part of this seventh pair passes through *Galen's foramen cæcum*, or *Fallopian's aquæduct*, in its crooked passage by the side of the *tympanum*; in which passage, a nerve sent from the lingual branch of the inferior maxillary nerve, along the outside of the *tuba Eustachiana*, and cross the cavity of the *tympanum*, where it has the name of *chorda tympani*, is commonly said to be joined to it. The very acute angle which this nerve makes with the fifth, or the sudden violent reflection it would suffer on the supposition of its coming from the fifth to the seventh, appears unusual; whereas, if we suppose that it comes from the seventh to the fifth, its course would be more in the ordinary way, and the *chorda tympani* would be esteemed a branch of the seventh pair going to join the fifth, the size of which is increased by this acquisition. This smaller bundle of the seventh gives branches to the muscles of the *malleus*, and to the *dura mater*, while it passes through the bony crooked canal, and at last comes out in a firm chord named *PORTIO DURA*, at the end of this canal, between the *styloid* and *mastoid* processes of the temporal bone, giving immediately filaments to the little oblique muscles of the head and to those that rise from the *styloid process*. It then pierces through the *parotid gland*, and divides into a great many branches, which

which are dispersed in the muscles and teguments that cover all the side of the upper part of the neck, the whole face and *cranium*, as far back as the temples, including a considerable part of the external ear. Its branches having thus a considerable connection with all the three branches of the fifth pair, and with the second cervical, occasion a considerable sympathy of these nerves with it.—Hence in the tooth-ach, the pain is sometimes very little in the affected tooth, compared to what it is all along the side of the head, and in the ear.—Hence probably the relief of the tooth-ach from blisters applied behind or before the ear, or by a hot iron touching the *antihelix* of the ear.—By this communication or connection possibly too it is, that a vibrating string held between one's teeth, gives a strong idea of sound to the person who holds it, which nobody else can perceive.—Perhaps too the distribution of this nerve occasions the head to be so quickly turned upon the impression of sound on our ears.

The *EIGHTH PAIR* of nerves rise from the lateral bases of the *corpora olivaria* in disgregated fibres; and as they are entering the anterior internal part of the holes common to the *os occipitis* and *temporum*, each is joined by a nerve which ascends within the *dura mater* from the tenth of the head, the first, second and inferior cervical nerves: This every body knows has the name of the *NERVUS ACCESSORIUS*. When the two get out of the scull, the *accessorius* separates from the eighth, and, descending obliquely outwards, passes through the *sterno-mastoideus* muscle, to which it gives branches, and afterwards terminates in the *trapezius* and *rhomboid* muscles of the *scapula*. In this course it is generally more or less joined by the second cervical nerve. Why this nerve, and several others which are distributed to muscles, are made to pierce through muscles, which they might have only passed near to, I do not know.

The large *eighth pair*, soon after its exit, gives nerves to the tongue, *larynx*, *pharynx*, and *ganglion*

of the *intercostal* nerve, and being disjoined from the ninth and intercostal, to which it adheres closely some way, runs straight down the neck behind the internal jugular vein, and at the external side of the carotid artery. As it is about to enter the *thorax*, a large nerve goes off from the eighth of each side: This branch of the right-side turns round from the fore to the back-part of the subclavian artery, while the branch of the left-side turns round the great curve of the *aorta*, and both of them mounting up again at the side of the *œsophagus*, to which they give branches, are lost at last in the *larynx*. These are called the *RECURRENT* nerves, which we are desired to shun in the operation of *bronchotomy*, though their deep situation protects them sufficiently.—The muscles of the *larynx*, being in a good measure supplied with nerves from the recurrents, it is to be expected, that the cutting of them will greatly weaken the voice, though it will not be entirely lost, so long as the superior branches of the eighth pair are entire.—Why the recurrent nerves rise so low from the eighth pair to go round a large artery, and to have such a long course upwards, I know not.

The eighth pair, above and at or near the place where the recurrent nerves go off from it, or frequently the recurrents themselves, send off small nerves to the *pericardium*, and to join with the branches of the intercostal that are distributed to the heart; but their size and situation are uncertain.

After these branches are sent off, the *par vagum* on each side descends behind the great branch of the *trachea*, and gives numerous filaments to the lungs, and some to the heart in going to the *œsophagus*. The one of the left side running on the fore part of the *œsophagus*, communicates by several branches with the right one in its descent to be distributed to the stomach: The right one gets behind the *œsophagus*, where it splits and rejoins several times before it arrives at the stomach, to which it sends nerves; and then being joined by one or more branches from the left-

left-trunk, they run towards the cælic artery, there to join into the great *semilunar ganglion* formed by the two intercostals.

From the distribution of this *par vagum*, we may learn how tickling the *fauces* with a feather or any such substance, excites a *nausea* and inclination to vomit;—why coughing occasions vomiting, or vomiting raises a cough.—Hence we see how the nervous *asthma* and the *tussis convulsiva*, chincough, are attended with a straitening of the *glottis*;—why food difficult to digest occasions the *asthma* to weakly people; and why *emetics* have frequently cured the *asthma* very speedily;—why an attempt to vomit is sometimes in danger of suffocating *asthmatic* people;—why the superior orifice of the stomach is so sensible, as to be looked on as the seat of the soul by some;—why people subject to distensions of the stomach, have so often the sensation of balls in their breasts and throats;—why the *globus hystericus* is so often attended with a violent strangulation at the *glottis*.

The *NINTH PAIR* of nerves comes from the inferior part of the *corpora pyramidalia*, to go out of the scull at their proper holes of the occipital bone. After their egress they adhere for some way firmly to the eighth and intercostal; and then sending a branch, that in many subjects is joined with branches of the first and second cervical nerves, to be distributed to the thyroid gland and muscles on the fore-part of the *trachea arteria*, the ninth is lost in the muscles and substance of the tongue. Some have thought this nerve, and others have esteemed the third branch of the fifth pair of nerves, to be the proper gustatory nerve. I know no observation or experiments to prove either opinion, or to assure us that both nerves do not serve for tasting and for the motion of the tongue.—May not the distribution of this nerve to the muscles below as well as above the *os hyoides*, contribute to their acting more uniformly in depressing the lower jaw or head?

The

The *TENTH PAIR* rises in separate threads from the sides of the *spinal marrow*, to go out between the *os occipitis* and *first vertebra* of the neck. After each of them has given banches to the great ganglion of the intercostal, 8th, 9th, and 1st cervical nerves, it is distributed to the straight, oblique, and some of the extensor muscles of the head. Whether the name of the tenth of the head, or of the first vertebral, ought to be given to this pair of nerves, is of no such consequence as to deserve a debate, though it has some of the marks of the spinal nerves, to wit, its being formed of filaments proceeding from both the fore and back part of the *medulla*, and a little *ganglion* being formed where these filaments meet.

In the description of the sixth pair, I followed the usual way of speaking among anatomists, and called that the beginning of the intercostal nerve which comes out of the scull; and therefore shall here subjoin a cursory description of this nerve, notwithstanding its much larger part is composed of nerves coming out from the *spinal marrow*. There is no greater incongruity in point of method to say, that the nerve we are describing receives additions from others that have not been described, than it is to repeat in the description of a great many nerves, that each of them gives branches to form a nerve which we are ignorant of; which is all the difference between describing the intercostal before or after the spinal nerves.

The branch reflected from the sixth pair, joined possibly by some filaments of the *ophthalmic* branch of the fifth, runs along with the internal carotid artery, through the crooked canal formed for it in the *temporal bone*, where the little nerve is very soft and pappy, and in several subjects divides and unites again, and is joined by one or more branches from the fifth, particularly of its superior maxillary branch before it comes out of the scull. May the compression of this nerve by the carotid artery when stretched during the *syntole*, contribute to the *diasystole* of the heart? As soon as the nerve escapes out of this bony canal,

canal, it is connected a little way with the eighth and ninth; then separating from these, after seeming to receive additional nerves from them, it forms a large *ganglion*, into which branches from the tenth of the head, and from the first and second cervical enter. From this ganglion the nerves come out again small to run down the neck along with the carotid artery, communicating by branches with the cervical nerves, and giving nerves to the muscles that bend the head and neck. As the *intercostal* is about to enter the *thorax*, it forms another ganglion, from which nerves are sent to the *trachea* and to the heart; these designed for the heart joining with the branches of the eighth, and most of them passing between the two great arteries and the auricles, to the substance of that muscle. The intercostal after this consisting of two branches, one going behind, and the other running over the fore-part of the subclavian artery, forms a new ganglion where the two branches unite below that artery, and then descending along the sides of the *vertebrae* of the *thorax*, receives branches from each of the dorsal nerves; which branches appearing to come out between the ribs, have given the name of *intercostal* to the whole nerve. Where the addition is made to it from the fifth dorsal nerve, a branch goes off obliquely forwards; which being joined by such branches from the sixth, seventh, eighth, and ninth dorsal, an anterior trunk is formed, and passes between the fibres of the *appendix musculosa*, of the diaphragm, to form, along with the other intercostal and the branches of the eighth pair, a large semilunar ganglion, situated between the celiac and superior mesenteric arteries; the roots of which are as it were involved in a sort of nervous net-work of this ganglion, from which a great number of very small nervous threads run out to be extended on the surface of all the branches of those two arteries, so as to be easily seen when any of the arteries are stretched, but not to be raised from them by dissection: and thus the *liver*, *gall-bladder*, *duodenum*, *pancreas*, *spleen*, *jejunum*,

jejunum, ilium, and a large share of the colon, have their nerves sent from this great *solar ganglion or plexus*.—May the peristaltic motion of the intestines depend in some measure on the passage of the intercostal nerves through the diaphragm?

Several fibres of this ganglion, running down upon the *aorta*, meet with other nerves sent from the posterior trunk of the intercostal, which continues its course along the sides of the *vertebrae*; they supply the *glandulae renales*, kidneys, and *testes* in men, or *ovaria* in women; and then they form a net-work upon the inferior mesenteric artery, where the nerves of the two sides meet, and accompany the branches of this artery to the part of the *colon* that lies in the left side of the belly, and to the *rectum*, as far down as to the lower part of the *pelvis*.

The intercostal continuing down by the side of the *vertebrae* of the loins, is joined by nerves coming from between these *vertebrae*, and sends nerves to the organs of generation and others in the *pelvis*, being even joined with those that are sent to the inferior extremities.

The almost universal connection and communication which this nerve has with the other nerves of the body, may lead us to understand the following, and a great many more *phenomena*:—Why tickling the nose causes sneezing.—Why the too great quantity of bile in the *cholera* occasions vomiting as well as purging.—Why people vomit in colics, in inflammations, or other irritations of the liver, or of the ducts going from it and the gall-bladder.—Why a stone in the kidneys, or ureters, or any other cause irritating those organs, should so much more frequently bring on vomiting and other disorders of the stomach, than the stone, or any other stimulating cause in the bladder does.—Why vomiting is a symptom of danger after child birth, lithotomy, and other operations on the parts in the *pelvis*.—Why the obstructions of the *menses* are capable of occasioning strangulations, belching, colics, stomach-aches, and even convulsions

convulsions in the extremities.—Why vesicatory, applied from the ears to the clavicles of children labouring under the *tussis convulsiva*, are frequently of great service.—Why worms in the stomach or guts excite an itching in the nose, or grinding of the teeth.—Why irritations in the bowels or the belly occasion sometimes universal convulsions of the body.

The *spinal nerves* rise generally by a number of disengaged fibres from both the fore and back-part of the *medulla spinalis*, and soon after form a little knot or ganglion, where they acquire strong coats, and are extended into firm cords. They are distinguished by numbers, according to the *vertebrae* from between which they come out; the superior of the two bones forming the hole through which they pass, being the one from which the number is applied to each nerve. There are generally said to be *thirty pair* of them; seven of which come out between the *vertebrae* of the neck, twelve between those of the back, five between those of the loins, and six from the *false vertebrae*.

The *FIRST CERVICAL* pair of nerves comes out between the first and second *vertebrae* of the neck; and having given branches to join with the tenth pair of the head, the second cervical and intercostal, and to serve the muscles that bend the neck, it sends its largest branches backwards to the extensor muscles of the head and neck; some of which piercing through these muscles, run up on the *occiput* to be lost in the teguments here; and many fibres of it advance so far forward as to be connected with the *fibrils* of the first branch of the fifth pair of the head, and of the *portio dura* of the *auditory nerve*.—Hence possibly it is that a *clonus hystericus* changes suddenly sometimes from the fore-head to a violent pain and spasm in the back-part of the head and neck.

The *SECOND CERVICAL* is soon joined by some branches to the ninth of the head and intercostal, and to the first and third of the neck; then has a large branch that comes out at the exterior edge of the *sterno-mastoideus* muscle, where it joins with the *accessorius*

accessorius of the eighth pair; and is afterwards distributed to the *platysma myoides*, teguments of the side of the neck and head, parotid gland, and external ear, being connected to the *portio dura* of the auditory nerve, and to the first cervical. The remainder of this second cervical is spent on the *levator scapulae* and the extensors of the neck and head. Generally a large branch is here sent off to join the *accessorius* of the eighth pair, near the superior angle of the *scapula*.

To the irritation of the branches of this nerve it probably is, that, in an inflammation of the parotid gland, the neck is pained so far down as the clavicle, the head is drawn towards the shoulder of the affected side, and the chin is turned to the other side.—In opening the external jugular vein, no operator can promise not to touch some of the cutaneous branches of this nerve with the lancet; which occasions a sharp pricking pain in the mean time, and a numbness of the skin near the orifice for some time after.

The *THIRD PAIR* of the neck passes out between the third and fourth cervical *vertebrae*; having immediately a communication with the second, and sending down a branch, which being joined by a branch from the fourth cervical, forms the *PHRENIC* nerve. This descending enters the *thorax* between the subclavian vein and artery; and then being received into a groove formed for it in the *pericardium*, it has its course along this *capsula* of the heart, till it is lost in the middle part of the diaphragm. The right phrenic has a straight course; but the left one is obliged to make a considerable turn outwards to go over the prominent part of the *pericardium*, where the point of the heart is lodged. Hence in violent palpitations of the heart, a pungent acute pain is felt near the left orifice of the stomach.—The middle of the diaphragm scarce could have been supplied by any other nerve which could have had such a straight course as the *phrenic* has. If the subclavian artery

artery and vein have any effect upon this nerve, I do not know it.

The other branches of the third cervical nerve are distributed to the muscles and teguments at the lower part of the neck and top of the shoulder. No wonder then that an inflammation of the liver or spleen, an abscess in the lungs adhering to the diaphragm, or any other cause capable of irritating the diaphragm, should be attended with a sharp pain on the top of the shoulder, as well as wounds, ulcers, &c. of this muscle itself.—If the irritation of this muscle is very violent, it may occasion that convulsive contraction of the diaphragm which is called an *hiccough*; and therefore an hiccough in an inflammation of the liver has been justly declared to be an ill symptom.

An irritation of the thoracic nerves which produces sneezing, may sometimes free the phrenic nerves from any spasm they occasion; so that sneezing sometimes takes away the hiccough; and a derivation of the fluid of the nerves any other way may do the same thing: Or the hiccough may also be sometimes cured, by drawing up into the nose the smoak of burning paper or other acrid fumes, swallowing pungent or aromatic medicines, and by a surprise, or any other strong application of the mind in thinking, or in distinguishing objects: Or, when all these have failed, it has been put away by the brisk *stimulus* of a blistering plaster applied to the back.

The *FOURTH CERVICAL* nerve, after fending off that branch which joins with the third to form the phrenic, and bestowing twigs on the muscles, and glands of the neck, runs to the arm-pit, where it meets with the *FIFTH, SIXTH, and SEVENTH CERVICALS*, and *FIRST DORSAL*, that escape in the interstices of the *musculi scaleni*, to come at the arm-pit, where they join, separate, and rejoin, in a way scarce to be rightly expressed in words; and after giving several considerable nerves to the muscles and teguments which cover the *thorax*, they divide into several branches, to be distributed to all the parts of

the superior extremity. Seven of these branches I shall describe under particular names.

1. *SCAPULARIS* runs straight to the *cavitas semi-lunata* of the upper *costa* of the *scapula*, which is a hole in the recent subject by a ligament being extended from one angle of the bone to the other, giving nerves in its way to the muscles of the *scapula*. When it has passed this hole, it supplies the *supra spinatus* muscle; and then descending at the anterior root of the spine of the *scapula*, it is lost in the other muscles that lie on the *dorsum* of that bone.

2. *ARTICULARIS* sinks downwards at the *axilla*, to get below the neck of the head of the *os humeri*, and to mount again at the back-part of it; so that it almost surrounds the articulation, and is distributed to the muscles that draw the arm back, and to those that raise it up.

3. *CUTANEUS* runs down the fore-part of the arm near the skin, to which it gives off branches; and then divides on the inside of the fore-arm into several nerves, which supply the teguments there, and on the palm of the hand.—In opening the basilic vein of the arm, at the ordinary place, the same symptoms are sometimes produced as in opening the external jugular vein, and from a like cause, to wit, from hurting a branch of this cutaneous nerve with the lancet.

4. *MUSCULO-CUTANEUS*, or *perforans Cafferii*, passes through the *coraco-brachialis* muscle; and after supplying the *biceps flexor cubiti* and *brachialis internus*, passes behind the tendon of the *biceps*, and over the cephalic vein, to be bestowed on the teguments on the outside of the fore-arm and back of the hand.—This nerve is sometimes hurt in opening the cephalic vein, and causes pain and numbness for a short time.

5. *MUSCULARIS* has a spiral course from the *axilla*, under the *os humeri*, and backward to the external part of that bone, supplying by the way the extensor muscles of the fore-arm, to which it runs between the two *brachiali* muscles, and within the *supinator*

supinator radii longus.—At the upper part of the fore-arm, it sends off a branch, which accompanies the *supinator longus* till it comes near the wrist, where it passes obliquely over the *radius*, to be lost in the back of the hand and fingers.—The principal part of this nerve pierces through the *supinator radii brevis*, to serve the muscles that extend the hand and fingers, whose actions are not injured when the *supinator* acts.

6. *ULNARIS* is extended along the inside of the arm, to give nerves to the muscles that extend the fore-arm and to the teguments of the elbow: Towards the lower part of the arm, it slants a little backward to come at the groove behind the internal condyle of the *os humeri*, through which it runs to the *ulna*: In its course along this bone, it serves the neighbouring muscles and teguments; and as it comes near the wrist, it detaches a branch obliquely over the *ulna* to the back of the hand, to be lost in the convex part of several fingers. The larger part of the nerve goes straight forward to the internal side of the *os pisiforme* of the wrist; where it sends off a branch which sinks under the large tendons in the palm, to go cross to the other side of the wrist, serving the *musculi lumbricales* and *interossei*, and at last terminating in the short muscles of the thumb and fore-finger. What remains of the ulnar nerve, after supplying the short muscles of the little finger, divides into three branches; whereof two are extended along the sides of the sheath of the tendons of the flexors of the little finger, to furnish the concave side of that finger; and the third branch is disposed in the same way upon the side of the ring finger next to the little finger.

When we lean or press on the internal condyle of the *os humeri*, the numbness and prickling we frequently feel, point out the course of this nerve. I have seen a weakness and atrophy in the parts which I mentioned this nerve to be sent to, after a wound in the internal lower part of the arm.

7. *RADIALIS* accompanies the humeral artery to the bending of the elbow, serving the flexors of the cubit in its way; then passing through the *pronator radii teres* muscle, it gives nerves to the muscles on the fore-part of the fore-arm, and continues its course near to the *radius*, bestowing branches on the circumjacent muscles. Near the wrist, it sometimes gives off a nerve which is distributed to the back of the hand, and the convex part of the thumb and several of the fingers, instead of the branch of the muscular. The larger part of this nerve, passing behind the annular ligament of the wrist, gives nerves to the short muscles of the thumb; and afterwards sends a branch along each side of the sheath of the tendons of the flexors of the thumb, fore-finger, mid-finger, and one branch to the side of the ring-finger, next to the middle one, to be lost on the concave side of those fingers.

Though the *radial* nerve passes through the *pronator* muscle, and the *muscular* nerve seems to be still more unsavourably placed within the *supinator brevis*; yet the action of these muscles does not seem to have any effect in hindering the influence of these nerves; for the fingers or hand can be bended while pronation is performing vigorously, and they can be extended while supination is exercised.

The manner of the going off of these nerves of the fingers, both from the *ulnar* and *radial*, is, that a single branch is sent from the trunk to the side of the thumb and little finger farthest from the other fingers; and all the rest are supplied by a trunk of a nerve, which splits into two some way before it comes as far as the end of the *metacarpus*, to run along the sides of different fingers that are nearest to each other.

It might have been observed, that, in describing the posterior branches of the *ulnar* and *muscular nerve*, I did not mention the particular fingers, to the convex part of which they are distributed. My reason for this omission is, the uncertainty of their distribution;

for

for though sometimes these posterior branches go to the same fingers, to the concave part of which the anterior branches of the *ulnar* and *radial* are sent, yet frequently they are distributed otherwise.

The situation of these brachial nerves in the *axilla*, may let us see, how a weakness and atrophy may be brought on the arms by long continued pressure of crutches, or such other hard substances on this part; and the course of them, from the neck to the arm, may teach us, how much better effects vesicatory, or stimulating nervous medicines, would have, when applied to the skin, covering the transverse processess of the *vertebra* of the neck, or at the *axilla*, than when they are put between the shoulders, or upon the spinal processess, in convulsions or palsies of the superior extremities, where a *stimulus* is required.

The *TWELVE DORSAL* nerves of each side, as soon as they escape from between the *vertebrae*, send a branch forward to join the intercostal, by which a communication is made among them all; and they soon likewise give branches backwards to the muscles that raise the trunk of the body, their principal trunk being extended outwards to come at the furrow in the lower edge of each rib, in which they run toward the anterior part of the *thorax*, between the internal and external intercostal muscles, giving off branches in their course to the muscles and teguments of the *thorax*.

The *FIRST* dorsal, as was already observed, is particular in this, that it contributes to form the brachial nerves; and that the two branches of the intercostal, which come down to the *thorax*, form a considerable ganglion with it.

The *SIX* lower dorsal nerves give branches to the diaphragm and abdominal muscles.

The *TWELFTH* joins with the first lumbar, and bestows nerves on the *musculus quadratus lumborum* and *iliacus interius*.

May not the communications of all these nerves be one reason, why the parts they serve act so uniformly

ly and conjunctly in respiration, and conspire together in the convulsive motions of coughing, sneezing, &c.—The twitching spasms that happen sometimes in different parts of the muscles of the *abdomen*, by an irritation on the branches of the lower dorsal nerves, are in danger of occasioning a mistake in practice, by their resemblance to the colic, *nephritis*, &c.—The communications of these lower ones with the intercostals may serve to explain the violent effort of the abdominal muscles in a *tetus* and in child-bearing.

As the intercostal is larger in the *thorax* than anywhere else, and seems to diminish gradually as it ascends and descends, there is cause to suspect, that this is the trunk from which the superior and inferior pairs are sent as branches.

The *FIVE LUMBAR* nerves on each side communicate with the intercostal and with each other, and give branches backwards to the loins.

The *FIRST* communicates with the last dorsal, sends branches to the abdominal muscles, to the *psoas* and *iliacus*, and to the teguments and muscles on the fore-part of the thigh; while its principal branch joins with the other nerves, to form the crural nerve.

The *SECOND LUMBAR* nerve passes through the *psoas muscle*, and is distributed nearly in the same way as the former; as is also the *THIRD*.

Branches of the *second*, *third*, and *fourth*, make up one trunk, which runs along the fore-part of the *pelvis*; and passing in the notch at the fore-part of the great hole common to the *os pubis* and *ischium*, is spent on the *adductor* muscles, and on the teguments on the inside of the thigh. This nerve is called the *OBTURATOR* or *POSTERIOR CRURAL NERVE*.

By united branches from the *first*, *second*, *third*, and *fourth* lumbar nerves, a nerve is formed that runs along the *psoas* muscle, to escape with the external iliac vessels out of the *abdomen*, below the tendinous arcade of the *external oblique* muscle. This nerve, which

which is named the *ANTERIOR CRURAL*, is distributed principally to the muscles and teguments on the fore-part of the thigh. A branch, however, of this nerve runs down the inside of the leg to the upper part of the foot, keeping near to the *vena saphena*; in opening of which with a lancet at the ankle, the nerve is sometimes hurt, and occasions sharp pain at the time of the operation, and numbness afterwards.

The remainder of the fourth lumbar and the fifth join in composing the largest nerve of the body; which is soon to be described.

Whoever attends to the course of these lumbar nerves, and of the spermatic vessels and nerves upon the *psoas* muscle, with the oblique passage of the *ureter* over that muscle, will not be surprised, that when a stone is passing in this canal, or even when it is inflamed, the trunk of the body cannot be raised erect, without great pain; or that the skin of the thigh becomes less sensible, and the thigh is drawn forward, and that the testicle often swells and is drawn convulsively towards the ring of the abdominal muscles.

The *SIXTH PAIR* of the false *VERTEBRÆ* consist each of small posterior branches sent to the hips, and of large anterior branches.

The *first, second, and third*, after coming through the three upper holes in the fore-part of the *os sacrum*, join together with the fourth and fifth of the loins, to form the largest nerve of the body, which is well known by the name of the *SCIATIC* or *ISCHIATIC* nerve: This, after sending large nerves to the different parts of the *pelvis*, and to the external parts of generation, and the *podex*, as also to the muscles of the hips, passes behind the great *tuber* of the *os ischium*, and then over the *quadrigemini* muscles, to run down near to the bone of the thigh at its back-part, giving off nerves to the neighbouring muscles and teguments. Some way above the ham, where it has the name of the *popliteus* nerve, it sends off a large branch that passes over the *fibula*, and sinking in

in among the muscles on the anterior external part of the leg, runs down to the foot, to be lost in the upper part of the larger toes, supplying the neighbouring muscles and teguments every where in its passage. The larger branch of the *sciatic*, after giving branches to the muscles and teguments about the ham and knee, and sending a large cutaneous nerve down the calf of the leg, to be lost at last on the outside of the foot, and upper part of the lesser toes, sinks below the *gemellus* muscle, and distributes nerves to the muscles on the back of the leg; among which it continues its course, till, passing behind the internal *malleolus*, and in the internal hollow of the *os calcis*, it divides into the two plantar nerves: The internal of which is distributed to the toes in the same manner that the *radial* nerve of the hand serves the concave side of the thumb and fingers; and the external *plantar* is divided and distributed to the sole of the foot and toes, nearly as the *ulnar* nerve is in the palm of the hand, and in the concave part of the fingers.

Several branches of these nerves, that serve the *inferior extremities*, pierce through muscles.

By applying what was said of the nerves in general to the particular distribution of the nerves of the *inferior extremities*, we may see how people with fractured legs, especially where there are splinters, should be subject to convulsive startings of the fractured member.—Why, upon tying the blood vessels in an amputation of the leg, the patients should sometimes complain of violent pain in their toes;—why such patients should also be troubled with startings;—why, for a considerable time after the amputation of the diseased limb, when the suppuration is well advanced, they should complain of pain in the sore which occasioned the amputation.

The *FOURTH*, which, with the two following, is much smaller than the three superior, soon is lost in the *vesica urinaria* and *intestinum rectum*.

The

The *FIFTH* comes forward between the extremity of the *os sacrum* and *coccygis*, to be distributed principally to the *levatores ani*.

The *SIXTH*, which some think to be only a production of the *dura mater*, advances forward below the broad shoulders of the first bone of the *os coccygis*, and is lost in the *sphincter ani*, and teguments covering it.

The branches of the four last cervical nerves, and of the first dorsal, which are bestowed on the *superior extremities*, and the two crurals, with the sciatic, which are distributed to the *inferior extremities*, are much larger proportionally to the parts they serve, than the nerves of the trunk of the body, and especially of the *viscera*, are; and for a very good reason, that, in the most common necessary actions of life, a sufficient quantity of fluid, on which the influence of nerves seems to depend, may be supplied to the muscles there, which are obliged to perform more frequent and violent contractions than any other parts do.—The size of the nerves of the *inferior extremities* seems larger proportionally than in the *superior extremities*; the *inferior extremities* having the weight of the whole body to sustain, and that frequently at a great disadvantage.—What the effect is of the nerves here being injured, we see daily, when people happen, by sitting wrong, to compress the sciatic nerve, they are incapable for some time after to support themselves on the affected *extremity*: And this is still more remarkable in the *sciatic* or *bip-gout*, in which the member is not only weakened, but gradually shrivels and wastes.

THE

THE
DESCRIPTION

Of the HUMAN
LACTEAL SAC AND DUCT.

THE receptaculum chyli of *Pecquet*, or *faccus lacteus* of *Van Horne*, is a membranous somewhat pyriform bag, two-thirds of an inch long, one-third of an inch over in its largest part when collapsed; situated on the first *vertebra* of the loins to the right of the *aorta*, a little higher than the right emulgent artery, behind the right inferior muscle of the diaphragm: It is formed by the union of three tubes, one from under the *aorta*, the second from the interstice of the *aorta* and *cava*, the third from under the emulgents of the right side. The *lacteal sac*, becoming gradually smaller towards its upper part, is contracted into a slender membranous pipe, of about a line diameter, which is generally named the *THORACIC DUCT*. This passes betwixt the muscular appendices or inferior muscles of the diaphragm, on the right of, and somewhat behind the *aorta*; then, being lodged in the cellular substance behind the *pleura*, it mounts between the *aorta* and the *vena azygos*, as far as the fifth *vertebra* of the *thorax*, where it is hid by the *azygos*, as this vein rises forwards to join the descending or superior *cava*; after which the duct passes obliquely over to the left side behind the

af

*œsophagus, aorta descendens, and the great curvature of the aorta, until it reaches the left carotid artery; behind which, on the left side of the *œsophagus*, it runs to the interstice of the first and second vertebra of the *thorax*, where it begins to separate from the carotid, stretching farther towards the left internal jugular vein by a circular turn, whose convex part is uppermost. At the top of this arch it splits into two for a line and an half; the superior branch receiving into it a large lymphatic vessel from the cervical glands. This lymphatic vessel appears, by blowing air and injecting liquors into it, to have few valves. When the two branches are again united, the duct continues its course towards the internal jugular vein, behind which it descends, and, immediately at the left side of the insertion of this vein, enters the superior posterior part of the left subclavian vein, whose internal membrane duplicated, forms a semilunar valve that is convex externally, and covers two-thirds of the orifice of the duct; immediately below this orifice, a cervical vein from the *musculi scaleni*, enters the subclavian.*

The coats of the *sac* and *duct* are thin transparent membranes; from the inside of which, in the duct, small semilunar valves are produced, most commonly in pairs; which are so situated as to allow the passage of liquors upwards, but oppose their return in an opposite course. The number of these is generally ten or twelve.

This is the most simple and common course, situation, and structure of the *receptaculum cibyli* and *thoracic duct*; but having had occasion to observe a variety in these parts, of different subjects, I shall set down the most remarkable of them.

The *sac* is sometimes situated lower down than in the former description; is not always of the same dimensions; is not composed of the same number of ducts; and frequently appears to consist of several small cells or ducts, instead of being one simple cavity.

The

The diameter of the duct is various in most bodies, and is seldom uniform in the same subject; but frequently sudden enlargements or *facciuli* of it are observable.—The divisions which authors mention of this duct are very uncertain. I have seen it divided into two, whereof one branch climbed over the fore-part of the *aorta* at the eighth *vertebra* of the *thorax*, and at the fifth slipped behind that artery, to join the other branch which continued in the ordinary course.—The precise *vertebra*, where it begins to turn to the left side, is also uncertain.—Frequently it does not split at its superior arch; in which case a large sac is found near its aperture into the subclavian vein.—Generally it has but one orifice; though I have seen two in one body, and three in another: Nay, sometimes it divides into two, under the curvature of the great artery; one goes to the right, another to the left subclavian vein; and I have found this duct discharging itself entirely into the right subclavian.—The lymphatic vessel which enters its superior arch, is often sent from the *thyroid* gland.

Whether is not the situation of the *receptaculum cibyli* so much nearer the muscular *appendices* of the diaphragm in men than in brutes, designed to supply the disadvantageous course the chyle must otherwise have in our erect posture?

Does not the descent of the end of the duct to the subclavian vein, and the opening of the lymphatic into the top of the arch, contribute to the ready admission of the chyle into that vein?

FOR I am in **N**eed of **I**nstruction
in **S**ome **part** of **my** **stu-**
dies **now**. **F**or I am in **N**eed of **I**nstruction
in **S**ome **part** of **my** **stu-**
dies **now**.

Comp. Anat. and Phys.

A N



E S S A Y
O N

Comparative Anatomy.

Vos minime fugit, plures esse humani corporis partes, quarum structura, et officium, et si non aliunde quam ex bestiis desumpta sint, nunc tamen in scholis accipiuntur, atque probantur.

Ant. M. Valsalva in dissert. Anatom. tertia.

Incidentia autem animalia, quibus partes illarum quārum actiones quārimus, eadem atque homini sunt, aut certe similes iis; ex quibus sine metu erroris judicare de illis hominī liceat. Quin et reliqua, si modo aliquam habeant ad hominem similitudinem, quantulaeunque sit, idonea sunt ad aliquid suppeditandum.

Albini Pref. ad Harvei Exercitationem de motu cordis.

THE THIRD EDITION.

Alexander Monro.

EDINBURGH:

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J. DICKSON FRONT OF THE EXCHANGE.

M,DCC,LXXXII,

H B S A Y
M O V
C o m p u s i t i o n e r A u t o m o

1880. 1881. 1882. 1883. 1884. 1885. 1886. 1887.
1888. 1889. 1890. 1891. 1892. 1893. 1894. 1895.
1896. 1897. 1898. 1899. 1900. 1901. 1902. 1903.
1904. 1905. 1906. 1907. 1908. 1909. 1910. 1911.
1912. 1913. 1914. 1915. 1916. 1917. 1918. 1919.
1920. 1921. 1922. 1923. 1924. 1925. 1926. 1927.
1928. 1929. 1930. 1931. 1932. 1933. 1934. 1935.

M O D E R N E D U C A T I O N

S E C O N D C H A P T E R

LETTERS TO W. GORDON STANTON-SMITH, M.A.
[A DICTIONARY OF THE EXPRESSIONS]

M DCC LXXVII.

A D V E R T I S E M E N T

512

TO THE

R E A D E R.

THE following sheets were found among the papers of a physician lately deceased, and sent by a friend of his to the bookseller, with liberty to print them. As the subject appeared useful, they were presented to two eminent physicians in town for their approbation: One of them was so good as to write the following letter, which, with difficulty we obtained leave to print, as it will serve for a preface to the whole. From what he there says, in relation to the subject and treatise, we presume the publishing it must be a service done the public.

A 2nd part will be sent as you

A LETTER, &c.

ТИМЕЗИАНА

SIR,

I HAVE read over the papers on *Comparative Anatomy*, which I now return you with thanks by this bearer. You desire my thoughts on the subject and treatise, and indeed the pleasure I had in the perusal makes your demand but just.—What is called *Comparative Anatomy* was certainly the first branch of the science that was cultivated, and from it the earliest anatomists formed their notion and system of the human body. The natural prejudices of mankind, and in some sense common humanity, opposed any attempts to be made in the other way. As the first physicians were philosophers, and this part of natural knowledge more immediately related to medicine, they particularly applied to it. Democritus, who, according to some, was the master of Hippocrates, spent much time in dissecting brutes, and examining their several parts. He applied himself with such eagerness to this study, as to incur the censure of madness. His design was to examine the nature of the bile, and learn the seat and causes of diseases. That this science was much improved by the times of Hippocrates, is very apparent from his writings, which are intermixed with reasonings drawn from it, and some parts of his physiology are only applicable to brutes. These passages appear to us exceeding obscure, often false and contradictory, and have for that reason been rejected by some very great critics.—But is not this owing to our own ignorance? We do not well understand the then received system of anatomy, and his terms and names do not correspond to ours. The small tract *de Vulneribus Capitis* is, I think,

think, as great a master-piece in its kind as the *Cosice Praelectiones*. Yet the first has been esteemed by some lame and imperfect; and afforded occasion for many disputes and wranglings, and all this because not understood: Anatomists however have done by Hippocrates in most cases as the critics with Homer, made him the master of all human and divine science. Not a new division of a bone, or dispute about a process of articulation, but has been referred to his judgment, and he has often been made to explain what he never dreamed of. Galen, the father of anatomists, is for the same reason in many places become an obscure writer. He is accused and defended by the greatest succeeding masters. Vesalius, the great restorer of anatomy, will not allow accuracy or truth in many of his descriptions; they are according to him taken from brutes, and obtruded on the world for *human*.

The other anatomists treat Vesalius much in the same manner, and with uncommon sagacity and unwearyed application have found out variations and *iusus naturae* in particular parts, that they may establish Galen's descriptions, and condemn those of Vesalius. This is particularly the case with Eustachius in his treatise on the kidneys. How shall we now understand Galen, and judge between these great anatomists. It is *Comparative Anatomy* alone can extricate us from this confusion, as it will teach us, when Galen and others described and reasoned from brutes, and when not. We shall then find (I believe) that the greatest part of his descriptions was taken from brutes, which he transferred by analogy to the human body, and so are inaccurate; that a few were taken from the human subject, and are not capable of being otherwise applied. This study he himself recommends with great earnestness to his scholars, and it is observable that the most eminent anatomists first discovered their genius, by an early attachment to

it. This was particularly the case of Vesalius and Valsalva *.

As the first knowledge the ancients gained in anatomy was from the dissection of brutes, so they formed the names and terms of art from the most natural appearance the part afforded, and that in different animals. Those names were applied to the corresponding parts in the human body, and retained by succeeding anatomists to avoid a multiplicity of words. This however produces one bad effect, that it must mislead us in our conceptions, as those names are often very improper epithets in the human subject. The author has elegantly remarked several of these. The name of right and left *ventricle* is apt to give a wrong idea of the position of the heart, and the *norta ascendens* and *descendens* has imposed on some of the masters in anatomy, who, it is plain, have taken their figures from the name. Disputes have arisen about the *appendix vermicularis*, &c. which are all cleared up when we once view the part in the animal whence the name was taken. A short technical dictionary, with an account of the subjects whence the names of the several parts were derived would be of great use to students, and is one of the *desiderata* in anatomy †.

The intention of nature in the formation of the different parts, can no where be so well learned as from this science; that is, if we would understand physiology and reason on the functions in the animalconomy, we must see how the same end is brought about in other species.—We must contemplate the part or organ in different animals, its shape, pos-

* Gaudebat enim avicularum, aliorumque animalium dissectionibus, eorumque exta curiosius, quam pro illa *estate*, rimabatur: quam ego præsignificationem, non in Vesalio tantum, sed in aliis quoque pueris fuisse scio, qui, cum adoleverint, anatomiae penitus se dediderunt. Morgagni Comment. de vita Valsalva.

† Such a treatise might in a great measure be collected from Sylvius's works, and Fætius's *DEconomia Hippocratis*. Camerarius did such a work under the title of *Animorum corporumq;*, but it is a rare book.

tion, connection with the other parts, &c. and ob-
serve what thence arises.—If we find one common effect
constantly produced, though in a very different
way, then we may safely conclude that this is the
use or function of the part; this reasoning can never
betray us, if we are but sure of the facts. The
writers in physiology have generally taken another
rout, and one favourite thesis or other serves to ex-
plain the whole or most of the system. An *innate*
and *concociting heat*, *acids*, *menstruum*, &c. have all
had their successive reigns and patrons. And, in
in truth, physicians seem not to have sufficiently con-
sidered the importance of this study to form a com-
plete physiology, which must ever be the great basis of
their art. They have bestowed pains in examining
the human body, dissected minutely its several parts,
traced out (perhaps often invented) a new division of
a muscle;—but how little has physic been promoted
by all this? The most accurate description of the hu-
man stomach, with all its veins, arteries, nerves, &c.
will never rightly explain digestion.—What must we
then do?—examine it in the other species of animals;
mark there its differences and the effects; compare
these with the human, and then shall we in some
measure be able to judge what are the principal instru-
ments, and how they are employed in this com-
pound action. Any other way of reasoning (as the
author well observes), will never bring us to the sol-
ution of a philosophical or medical problem. It must
indeed be confessed, that this method is tedious and
slow; many observations must first be made, and the
labour of searching and examining gone through,
before we can have proper materials to build on.
Yet these are the hard conditions on which the know-
ledge of natural causes is to be obtained, which, as a
great genius says, “ Tam facile solertia vinci pos-
“ sunt, quam solent conatibus vulgaribus difficuler
“ cedere.”

Of this kind of reasoning, we have many beautiful
instances in the following papers; such is the account
of

of the position of the *duodenum*, the history of the *thymus* and *thyroïd gland*, their use and mutual proportion, the use of the *spleen*, &c. This last he explains in so short and masterly a manner, as you'll find more argument in the few lines upon it, than is to be collected from whole treatises on the subject. But as his design was to give a description of the several species, or rather their principal differences, he chiefly confines himself to this: So in the anatomy of the dog he compares the different position, shape, length, &c. of the several parts with the corresponding parts in man, and from that one circumstance, the difference of an erect and horizontal posture, explains all the variations. This reasoning then gives solution to many difficulties in the human anatomy; why the *spleen* is firmly attached to the *diaphragm*, why the *omentum* reaches only so far, why the posterior part of the *bladder* only covered by the *peritoneum*, &c. — There have been disputes about the *fissure* in the human *liver*, and different accounts given. These all vanish, when we consider this *viscus* in different animals. We then find that there are more or fewer divisions, according to the greater or lesser flexibility of the *spine*. The same rule holds with regard to the divisions of the *lungs*. This reasoning likewise excludes the pretended use of the *ligament* in the human *liver*. And in short we can understand but little of our own structure, unless we study that of other animals; we shall then find that the several variations are *relative* and depend on the different way of life; that is, one leading *speciality* draws after it a great many more, in which nature is always an *oeconomist* and takes the shortest rout.

The beautiful *gradation* of nature in the different orders of beings, is very remarkable, and strikes the mind first, as being most obvious; but when we take any one species, the case there is still the same, and we observe as surprising a difference. Thus in the animal kingdom, some are provided with *lungs*, when others are deprived of these breathing organs; some have

have a muscular *diaphragm* and strong *abdominal muscles*, others a mere *membrane*; some have *liver*, others want them. It must be very entertaining to learn how these differences and deficiencies are adjusted and supplied; 'tis then from this science alone we can understand that *simplicity* of nature, which is much talked of, and but little understood. Hence likewise we must learn what to think of animals *perfect* and *imperfect*.—

Anatomists have made a noise about the different structures of the same part in the human body, and been at great pains to make collections of those *curiosities* as they call them; which, because they are rare, are for that very reason of no great consequence to be known. The epithet however is extremely proper; for the most remarkable of them are transitions from the *order* or *law* of nature that obtains in one species, to that of another. Thus it has been observed (though very rarely) that the *liver* was situated in the left *hypochondrium*; but as our author remarks, it is not peculiar to it to lye on the right side in animals; for in fowls it lies equally on both, and in fishes mostly on the left.

It is surprising that we have no tolerable treatise on this subject, which is in itself so entertaining, and so conducive to promote medicine. Those, who have made attempts this way, have only collected and ranged in order some particular *species*, such as birds or fishes. They have likewise with great labour given us figures and descriptions of them,—but all this is little else than mere amusement. 'Tis the structure of the internal organs we seek after, and the manner how the different functions of the animal oeconomy are performed. Their histories of these are every way defective and erroneous. There are indeed noble hints to be found in the writings of some of our modern anatomists, particularly those of the immortal Dr *Harvey*. That great man well understood the importance of this science to advance medicine, and accordingly employed the most of his time

time in dissecting animals of different tribes, and making experiments on them : by which means he made the greatest discovery that ever was in the science, and laid the foundation of the present system. He had certainly left us other treatises on the subject, had he not been interrupted by the civil wars. The physicians who lived then, imitating his example, made many new experiments on the bodies of brutes, changing their juices by transfusing of new liquors, accurately marking the effects, &c. that all this might be transferred to the human body ; and indeed, from the application of these reasonings, to the observations they made on morbid bodies, the science seemed fast advancing to that physical certainty, which can be attained from experiment and observation. But alas ! this spirit died with these great men, and theory and calculation came in its place. *Mathematics*, it was said, could alone bring the science to certainty, and throw out conjecture. The quantity and velocity of the blood, the force of the heart, diameters of the vessels, &c. were subjected to measure and number, and diseases next were to be accounted for all in a mathematical manner. This method however did not succeed according to wish ; for first these great geniuses disagreed widely in their calculations, and differed from one another ; whence in place of certain conclusions we had only wranglings and disputes : not to mention, that some of them made such estimates, as must plainly appear ridiculous at first sight (*). This, you'll say, proves

(*) The ingenious Dr *Pitcairn* was the chief man in these parts, who gave into this way. He supposes the force of muscles to be in a compound ratio of their length, breadth and depth ; that is, as they are homogeneous solids in the ratio of their weights. Whence knowing the force of any one muscle, we can by the rule of proportion (from their weights) determine that of another. This he applies to the stomach, and by the computation its muscular force is equal at least to 117088 lb. weight. — That muscles are in that proportion, is a mere hypothesis, for which the doctor does not offer the smallest proof ; and had he assigned five ounces as the weight of the stomach, he had been nearer the truth. This is one glaring instance, how much theory and whim may prevail with the greatest of men over common sense.

nothing

nothing, it was the fault of the artists, who assumed wrong hypotheses for their calculations, or were not perhaps accurate in their observations. True,—but whose fault was it to adapt figure and number to a subject which refuses them, through its numberless deviations from fixed laws and conditions?—Is an animate body a mere bundle of hard conical elastic tubes, and the heart a pump forcing the liquors through? Are then all the vessels exact cones, or have any two *anatomists* agreed in their measures of them? Do they not yield every way? And are they not continually obstructed in different places? Are they not many different attractions prevailing for the several secretions, and many different forces acting on the vessels at the same time, which can never be determined? &c. These and such like considerations will soon convince us how little the practice of medicine is to be promoted by those speculations (*). If these gentlemen meant by mathematical reasoning physical experiments, then no one ever doubted of this, no more than they do of the use of mathematics in natural philosophy itself. But as this seems not to be their sense of the matter, they should point out a few diseases which this science has explained, and wherein it has corrected the received practice—But I am quite got from the subject to what is foreign. To return then, *Comparative Anatomy* has hitherto been treated but by pieces. Thus some writing on the human eye, have examined the eyes of other animals; and so with regard to the heart, &c. Some have given us the description of

(*.) The authority of Hippocrates is often adduced in this argument, for which they cite two passages. In the one he recommends the study of *astronomy*, as necessary to a physician, and in the other, that of *arithmetic* and *geometry*.—The first he did from his belief in the influence of the stars, and the second from his veneration for the *Pythagoric numbers*; in the mysteries of which he founded his theory of the crises in acute diseases: Both these considerations then are foreign to the purpose, nor is there in any of his genuine writings the smallest vestige of this kind of reasoning. On the contrary Celsus says of him, *Primus ab studio sapientiae medicinam separavit.*

one particular animal, others of another. But no one author, as I know of, has given us a system of this science, where we might have a summary view of the most material differences in the structure of animals. There are indeed compends of this science if you will, which are esteemed by many, and were wrote with the noble design of illustrating the wisdom and goodness of our maker. But those who composed them were not anatomists themselves, so could only collect from others, which they often do without any judgment—for how voluminous soever their works may be, yet if you'll strip them of their repeated exclamations, citations of authors and books, the many strange and surprising stories, all told however by creditable vouchers, you'll have little left behind besides an indigested chaos of histories and descriptions, some true and many false. The argument however was popular, and they could not fail of pleasing.

The author of these few sheets is certainly a great master of the subject, and has here laid down an useful plan, which will not be difficult for others to compleat. The descriptions, 'tis easy to see, are all taken from the life, and his reasoning plain and conclusive. These are intermixed with many practical observations in medicine and surgery, which must equally instruct and entertain the reader.—You have now a few loose reflections on this subject, wherein I have entirely confined myself to that light, in which it is here treated. I shall only remark one thing more, that the author's modesty is at least equal to his capacity and knowledge; a rare quality to be met with in an anatomist! Read him on the subject of the *Human Alantois*, and observe his conclusion of the argument. You must then say, it had been happy for the public, if half so much candour and self-diffidence had prevailed in the disputes among the learned. The world had been more instructed, and they more justly esteemed.

I am, Sir,

and

Your most humble Servant.

MOTTSUDONTINENT

daily trades, numerous though they are, of no particular
character, and in which **A N** number of good workmen
are always to be found, and in which there is no
great difficulty in finding workmen to sufficient numbers.

E S S A Y

on some of the most interesting subjects in
the modern history of science, and in
O N one of the most
curious and interesting branches of ex-

Comparative Anatomy.

have been made of school, or to introduce more
knowledgeable persons to foreign institutions, and
so it is now omitted in the first form of paper
which has now become the object of the whole

nowise consists of any thing but a few very late
and short accounts of the state of the sciences in
various countries, and the like, and the like, and the
THE INTRODUCTION.

THE principal advantages of Comparative Anatomy are the following : First, it furnishes us with a sufficient knowledge of the different parts of animals, to prevent our being imposed upon by such authors who have delineated and described several parts from brutes as belonging to the human body. Secondly, It helps us to understand several passages in the ancient writers in medicine, who have taken many of their descriptions from brutes, and reasoned from them ; their reasonings have often been misapplied (and consequently wrong explained) by the moderns, through a foolish fondness to support their own inventions, or give an air of antiquity to a favourite hypothesis. The third and great use we reap from this science is the light it casts on sev-

ral functions in the human œconomy, about which there have been so many disputes among anatomists : These will be in a great measure cleared up by exhibiting the structure of the same parts in different animals, and comparing the several organs employed in performing the same action, which in the human body is brought about by one more complex.

In this view it is altogether needless to insist on those parts whose use is easily understood when once their structure is unravelled; thus, for instance, if we be acquainted with the action of the muscles in general, it will not be difficult to determine the use of any particular muscle, whose origin and insertion is known, if we at the same time consider the various connections of the bones to which it is fixed, and the different degree of mobility they have with respect to each other : In the same manner, if we know the use of the nerves in general, we can easily assign the use of those nerves which are distributed to any particular part. There is then no occasion for a complete *osteology, myology, &c.* of the several animals we shall treat of, nor need we trouble ourselves about the structure of any of the parts, unless when it serves to illustrate some of the fore-mentioned purposes.

That the first use we proposed from examining the structure of the parts in brutes is real and of consequence, is evident from looking into the works of some of the earliest and greatest masters of anatomy, who for want of human subjects, have often borrowed their descriptions from other animals. The great Vesalius; although he justly reproves Galen for this fault, is guilty of the same himself, as is plain from his delineations of the kidneys, *uterus*, the muscles of the eye, and some other parts. Nor is antiquity only to be charged with this, since in Willis's *Anatomia Cerebri* (the plates of which were revised by that accurate anatomist Dr Lower), there are several of the pictures taken from different brutes, especially the dog, besides those he owns to be such.

We

We shall give several examples of the second use in the sequel of the work.

The animal kingdom, as well as the vegetable, contains the most surprising variety, and the descent in each is so gradual, that the little transitions and deviations are almost imperceptible. The bat and flying-squirrel, though quadrupeds, have wings to buoy themselves up in the air. Some birds inhabit the waters, and there are fishes that have wings, and are not strangers to the airy regions; the amphibious animals blend the *terrestrial* and *aquatic* together.

The animal and vegetable kingdoms are likewise so nearly connected, that if you take the highest of the one, and the lowest of the other, there will scarce be preserved any difference: For instance, what difference is there betwixt an oyster, one of the of the most inorganised of the animal tribe, and the sensitive plant, the most exalted of the vegetable kingdom? they both remain fixed to one spot, where they receive their nourishment, having no proper motion of their own, save the shrinking from the approach of external injuries. Thus we observe a surprising chain in nature.

As there is then such a vast variety, it is not only needless but impossible to consider all of them particularly. We shall take only some of the most remarkable *genera*, and hope from what will be said of them any of the intermediate degrees may be understood.

In treating of *quadrupeds*, we shall divide them into the *carnivorous*, i. e. those that feed indifferently on animal and vegetable substances, and *granivorous*: As an instance of these last we shall take the ruminant kind. The fowls we shall also divide into those that feed on grain and those that feed on flesh. The distinction we shall make in treating of fishes, shall be of those that have lungs, and those that have them not. The first indeed are with difficulty procured, and at the same time differ very little from *quadrupeds*.

THE INTRODUCTION.

As the structure of insects is so very minute, and lends us but little assistance for the ends proposed, we purposely omit them.

In inquiring into the structure of different animals, we ought to be previously acquainted with the form of their body, manner of life, kind of food; or, in short, with their natural history, which will lead us to account for the reason of their different structure, and thence explain the actions of the human body.

Of Quadrupeds in General.

ALL quadrupeds have a covering of hair, wool, &c. to defend them from the injuries of the weather, which varies in thickness according to the season of the year, and difference of the climate. Thus in Russia and the northern countries, the furs are very thick and warm, while the little Spanish lap-dogs, and Barbary cows, have little or no hair at all.

The *cutis* and *cuticula* in quadrupeds are disposed much in the same way as the human, only more elastic; immediately under this there is a very thin cutaneous muscular substance called *panniculus carnosus*, which is common to all quadrupeds, the porcine kind excepted; this principally covers the trunk, serving to shrivel the skin, in order to drive off insects, their tails and heads not being sufficient for this purpose, while their extremities are employed in their support and progression.

It has probably been from observing some muscles of the human body, such as the *platysma myoides*, *cremaster*, and *frontalis*, and the collapsed *tunica cellulosa* of emaciated subjects, to resemble this thin muscle, that some of the older anatomists reckoned such a *panniculus* among the common *teguments* of the human body. This *Carolus Stephanus* has well observed.

Most part of quadrupeds want *clavicles*, whereby their anterior extremities fall upon their chest, so as to make their *thorax* proportionally narrower than the human. This small distance of their anterior extremities is very necessary for their uniform progression: Apes indeed and squirrels have *clavicles* to allow them a more full use of their extremities in climbing, B. 3

ing, but when they sit down on all-four they walk but indifferently.

The Anatomy of a Dog.

WE may first observe of this animal, as indeed of most quadrupeds, that its legs are much shorter in proportion to its trunk than in man, the length of whose steps depends entirely on the length of his inferior extremities; however, to balance this, the trunk of the animal is proportionably longer and smaller, his spine more flexible, by which he is able at each step to bring his posterior extremities nearer to his anterior. His common teguments are much akin to those of other quadrupeds, only they allow little or no passage for sweat, but when he is over-heated, the superfluous matter finds an exit by the salivary glands, for he lolls out his tongue and slavers plentifully.

The pyramidal muscles are wanting, to supply which the *rectus* is inserted fleshy into the *os pubis*.

The *omentum* reaches down to the *os pubis*, which considering the posture of the animal we will find to be a wise provision, since its use is to separate an oily liquor for lubricating the guts and facilitating their peristaltic motion; so in our erect posture the natural gravity of the oil will determine it downward, but in the horizontal position of these creatures, if all the *intestines* were not covered, there would be no favourable derivation of the fluid to the guts lying in the posterior part of the *abdomen*, which is the highest; and besides, had the *omentum* reached much farther down in us, we had been in continual hazard of an *epiplocele*, which the dog is not subject to, as his *viscera* don't press so much on the rings of the *abdominal* muscles. The inferior and anterior *Lamella* of the *omentum* is fixt to the *spleen*, *fundus* of the *stomach*, *pylorus*, *liver*, &c. in the same way as the human, but the superior having no *colon* to pass over,

nature of the Omentum

COMPARATIVE ANATOMY. 7

over, goes directly to the back-bone. This serves to explain the formation of the small *omentum* in the human body, which is nothing but the large *omentum*, having lost its fat, passing over the stomach and *colon*, where it reassumes its *pinguedo*, so proceeds and is firmly attached to the liver, spine, &c. The striae of fat are pretty regularly disposed through it, accompanying the distribution of the blood-vessels to guard them from the pressure of the super-incumbent *viscera*.

This animal's stomach, though pretty much resembling the human in its shape, is somewhat differently situated. It lies more longitudinal, as indeed all the other *viscera* do, to accommodate themselves to the shape of the cavity in which they are contained, that is, its inferior orifice is much farther down with respect to the superior than the human: By this means the gross food has an easier passage into the *duodenum*. Again, the *fundus* of the human stomach, when distended, stands almost directly forwards, which is occasioned by the little *omentum* tying it so close down to the back-bone, &c. at its two orifices; but it not being fixed in that manner in the dog, the *fundus* remains always posterior: This also answers very well the shape of the different cavities, the distance betwixt the *cardia* and *fundus* being greater than that betwixt the two sides. It seems to be much larger in proportion to the bulk of the animal than the human, that it might contain a greater quantity of food at once, which was very necessary, since this animal cannot at any time get its sustenance as men do. The *turbation* is not so large, nor is there any coaction forming the *antrum willisi* as in the stomach of man. It is considerably thicker and more muscular than ours for breaking the cohesion of their food, which they swallow without sufficient chewing. Hence it is evident the force of the stomach is not so great as some would have it, nor its contraction so violent; otherwise that of dogs would be undoubtedly wounded by the sharp bones.

&c.

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&c. they always take down ; for the contraction here is still greater than in the human stomach, which is much thinner. The *ruga* of the *tunica villosa* are neither so large nor situated transversely as in the human, but go from one orifice to the other ; the reason of which difference is, perhaps, that they might be in less danger of being hurt by the hard substances this creature frequently feeds upon, and for the same reason there is not the like coarction at their *pylorus*.

The *intestines* of this animal are proportionally much shorter than ours, for the food which these creatures mostly use, soon dissolves and then putrifies ; on which account there was no occasion for a long tract of *intestines*, but on the contrary that it should be quickly thrown out of the body : the same is to be observed of all the carnivorous animals. The muscular coat of the *intestines* is also stronger than the human, to protrude the hard bones, lest they should stop somewhere in the canal.

The *valvulae conniventes* are less numerous, and in a longitudinal direction.

The *duodenum* differs considerably in its situation from the human ; for in man it first mounts from the *pylorus* upwards, backwards, and to the right side, then passes down by the gall-bladder, and marching over the right kidney and superior part of the *psoas muscles*, makes a curvature upwards, and passes over the back bone and *vena cava inferior*, to the left *hypochondrium*, where it gets through the *omentum*, *mesentery* and *mesocolon* to commence the *jejunum*, being firmly tied down all the way, the *biliary* and *pancreatic ducts* entering at its most depending part : whereas in the dog the *duodenum* is fixed at the *pylorus* to the concave surface of the liver, and hangs loose and pendulous with the *mesentery* backwards into the cavity of the *abdomen*, then turning up again is fixed to the back-bone where it ends in the *jejunum* ; the bile and *pancreatic juice* are poured into it at the most depending part ; therefore the same intention seems

seems to have been had in view in the formation of this part in both, viz. the giving the chyle, after the liquors of the liver and *pancreas* are poured into it, a disadvantageous course, that so it might be the more intimately blended with the humours before its entry into the *jejunum*, where the *lacteals* are very numerous: And thus by reason of their different posture, the same design (though by a very different order of the parts) is brought about in both.

The other small guts are much the same with ours, only shorter. The great guts are also shorter and less capacious than in the human body: and we take it for a general rule, that all animals that live on vegetable food, have not only their small guts considerably longer, but also their great guts more capacious than such creatures as feed on other animals. Hence man from this form of his *intestines* and that of the *teeth*, seems to have been originally designed for feeding on vegetables, and still the most of his food and all his drink is of that class.

The reason of this difference seems to be, that as animal food is not only much more easily reduced into *chyle*, but also more prone to putrefaction, too long a *remora* of the juices might occasion the worst consequences. So it was necessary that their receptacles should not be too capacious, but on the contrary, being short and narrow, might conduce to the seasonable discharge of their contents. Whereas vegetable food being more difficultly dissolved and converted into an animal nature, there was a necessity for such creatures as fed on it to be provided with a long internal canal, that this food in its passage might be considerably retarded, and have time to change its *indoles* into one more agreeable to our nature. Besides which, there is another advantage which accrues to man in particular, from having his great guts very capacious; for as he is a rational being, and mostly employed in the functions of social life, it would have been very inconvenient as well unbecoming for him to be too frequently employed in

in such ignoble exercises, so that having this large reservoir for his *faeces alvineæ*, he can retain them for a considerable time without any trouble.

The *appendix vermicularis* justly enough deserves the name of an *intestinum cecum* in this subject, though in the human body it does not, and it has probably been from the largeness of this part in other animals, that the oldest anatomists came to reckon that small appendicle in man as one of the great guts: On its internal surface we observe a great number of mucous glands.

The *colon* has no longitudinal ligaments, and consequently this gut is not pursed up into different bags or cells as the human, nor does this *intestine* make any circular turn round the *abdomen*, but passes directly across it to the top of the *os sacrum*, where it gets the name of *rectum*.

At the extremity of the *intestinum rectum* or verge of the *anus*, there are found two bags or paunches, which contain a most abominable fetid mucus, for which I know no use, unless it serves to lubricate the strained extremity of the *rectum*, and defend it against the asperity of the *faeces*, or to separate some liquor that might otherwise prove hurtful to their bodies. There is nothing analogous to these sacs in the human subject, unless we reckon the mucilaginous glands that are found most frequent and largest about the lower part of the *rectum*.

The *mesentery* is considerably longer than in the human body, for in man had the *mesentery* been very long, the guts would have fallen down on the stomach, &c. by reason of his erect position. The fat is here disposed in the same way, and for the same reason, as in the *omentum*. The interstices betwixt the fat are filled with a fine membrane. Instead of a great number of *glandulae vagae* to be found in the human *mesentery*, there is only one large gland to be observed in the middle of the *mesentery* of a dog, which from its imagined resemblance to the *pancreas* and the name of its discoverers, is called *pancreas*.

pancreas Asellii. The reason why this in man is as it were subdivided into many smaller ones, may possibly be, that as the guts of a human body are proportionally much longer than those of this creature, it would have been inconvenient to have gathered all the *laetæ primi generis* into one place, whereas by collecting a few of these vessels into a neighbouring gland, the same effect is procured much more easily.

The *pancreas* in man lies cross the *abdomen*, tied down by the *peritoneum*; but the capacity of this creature's *abdomen* not allowing of that situation, it is disposed more longitudinally, being tied to the *duodenum* which it accompanies for some way. Its duct enters the *duodenum* about half an inch below the others.

The spleen of this animal differs from ours very much, both in figure and situation. It is much more oblong and thin, and lies more according to the length of *abdomen*, like the *pancreas*. Though the spleen of this creature is not firmly tied to the *diaphragm* (which was necessary in our erect posture to hinder it from falling downwards) yet by the animal's prone position, its posterior parts being rather higher than the anterior, it comes to be always contiguous to this muscle, and is as effectually subjected to an alternate pressure from its action as the human spleen is.

The human liver has no *fissures* or divisions, unless you please to reckon that small one betwixt the two *pyle*, where the large vessels enter: Whereas in a dog and all other creatures that have a large flexion in their spine, as lions, leopards, cats, &c. the liver and lungs are divided into a great many lobes by deep sections, reaching the large blood-vessels, which in great motions of the back bone may easily shuffle over one another, and so are in much less danger of being torn or bruised, than if they were formed of one entire piece, as we really see it in horses, cows, and such creatures as have their back-bone

back-bone stiff and immoveable. There is here no *ligamentum latum* connecting the liver to the *diaphragm*, which in our situation was necessary to keep the *viscus* in its place; whereas in this creature it naturally gravitates forwards, and by the horizontal position of the animal is in no danger of pressing against the *vena cava*: The preventing of which is one use generally assigned to this *ligament* in man. Had the liver of the dog been thus connected to the *diaphragm*, the respiration must necessarily have suffered; for as we shall see afterwards, this muscle is here moveable at the center, as well as at the sides: But in man the liver is fixed to the *diaphragm*, mostly at its tendinous part; that is, where the *pericardium* is fixed to it on the other side; so that it is in no danger of impeding the respiration, being suspended by the *mediastinum* and bones of the *thorax*. In consequence of this *viscus* being divided into so many *lobes*, it follows that the *hepatic ducts* cannot possibly join into one common trunk till they are quite out of the substance of the liver.

We come next, after having examined the *chylopoietic viscera*, to discourse of those organs that serve for the secretion and excretion of urine, and first of the kidneys, which in this animal are situated much in the same way as in the human subject, but have no fat on their inferior surface, where they face the *abdomen*, and are of a more globular form than the human. The reason of these differences will easily appear, if you compare their situation and posture in this animal with those of a man who walks erect. They are placed in this subject in the inferior part of the body, so are not subject to the pressure of the *viscera*, which seems to be the principal cause of the fatness of those organs in us, and perhaps may likewise be the cause of our being more subject to the stone than other animals. Hence there is no need of any cellular substance to ward off this pressure where there would necessarily be fat collected; but the superior part of their kidneys is pretty well covered

vered with fat, lest they should suffer any compression from the action of the ribs and spine.

In the *internal* structure there is still a more considerable difference, for the *papillæ* do not here send out single the several *tubuli uriniferi*, but being all united they hang down in form of a loose pendulous flap in the middle of the *pelvis*, and form a kind of *septum medium*, so that a dog has a *pelvis* formed within the substance of the kidney. The only thing that is properly analogous to a *pelvis* here, is that sac or dilatation of the *ureters* formed at the union of the *ductus uriniferae*. The reason of these particularities may probably be, that the liquors of this animal, as of all those of the carnivorous kind, being much more acrid than those that live on vegetable food, its urine must incline much to an alkaleficiency, as indeed the smell and taste of that liquor in dogs, cats, leopards, &c. evidently shew, being fetid and pungent, and therefore not convenient to be long retained in the body. For this end it was proper, that the secerning organs should have as little impediment as possible by pressure, &c. in the performing their functions; and for that design, the mechanism of their kidneys seems to be excellently adapted: We have most elegant pictures in Eustachius of the kidneys of brutes delineated, as such, with a view to shew Vesalius's error in painting and describing them for the human.

The *glandulae* or *capsulae atrabilarioe* are thicker and rounder than the human, for the same reason as the kidneys.

The *ureters* are more muscular than the human, because of the favourable passage the urine has through them; they enter the *bladder* near its *fundus*.

The bladder of urine differs considerably from the human, and first in its form, which is pretty much pyramidal or pyriform; this shape of the dog's bladder is likewise common to all *quadrupeds*, except the ape and those of an erect posture. In men it

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is by no means pyriform, but has a large sac at its posterior and inferior part : This form depends entirely on the urine gravitating in our erect posture to its bottom, which it will endeavour to protrude, but as it cannot yield before, being contiguous to the *os pubis*, it will naturally stretch out where there is the least resistance, that is, at the posterior and lateral parts ; and were it not for this sac, we could not come at the bladder to extract the stone either by the lesser or lateral operation of *lithotomy*. Most anatomists have delineated this wrong so much, that I know of none who have justly painted it, excepting Mr Cowper in his *myotomia*, and Mr Rully. It has certainly been from observing it in brutes and young children, that they have been led into this mistake. The same cause, *viz.* the gravity of the urine, makes the bladder of a different form in brutes ; in their horizontal position, the *cervix*, from which the *urethra* is continued, is higher than its *fundus*, the urine must therefore distend and dilate the most depending part by its weight.

As to its connection, it is fastened to the *abdominal* muscles by a process of the *peritoneum*, and that membrane is extended quite over it ; whereas in us its superior and posterior parts are only covered by it : Hence in man alone the high operation of *lithotomy* can be performed without hazard of opening the cavity of the *abdomen*. Had the *peritoneum* been spread over the bladder in its whole extent, the weight of the *viscera* in our erect posture would have so bore upon it, that they would not have allowed any considerable quantity of urine to be collected there ; but we must have been obliged to discharge its contents too frequently to be consistent with the functions of a social life. Whereas by means of the *peritoneum* the urine is now collected in sufficient quantity, the *viscera* not gravitating this way.

You may take it for a general rule, that those creatures that feed upon animal food have their bladder more muscular and considerably stronger, and less

less capacious than those that live on vegetables, such as horses, cows, swine, &c. whose bladder of urine is perfectly membranous, and very large. This is wisely adapted to the nature of their food, for in these first, as all their juices are more acrid, so in a particular manner their urine becomes exalted, which as its *remora* might be of very ill consequence, must necessarily be quickly expelled. This is chiefly effected by its stimulating this *viscus* more strongly to contract, and so discharge its contents. That a *stimulus* is one of the principal causes of the excretion of urine, we learn from the common saline diuretic medicines that are given, which are dissolved into the *serum* of the blood, and carried down by the kidneys to the bladder: The same appears likewise from the application of *cantharides*, or without any of these, when the parts are made more sensible, as in an excoriation of the bladder, there is a frequent desire to make water. Accordingly we find these animals evacuate their urine much more frequently than man, or any other creature that lives on vegetable food. And if these creatures, whose fluids have already a tendency to putrefaction, are exposed to heat or hunger, the liquids must for a considerable time undergo the actions of the containing vessels, and frequently perform the course of the circulation without any new supplies of food; by which the fluids becoming more and more acrid, the creature is apt to fall into feverish and putrid diseases; and in fact we find that those causes are sufficient to produce that fatal and melancholy distemper, the *rabies canina, vulpina, &c.* in these animals; whereas those that feed on vegetable food seldom or never contract these diseases but by infection.

The *spermatic* vessels are much the same way disposed as in us; they are contained within the cavity of the *abdomen*, as the guts are within the *peritoneum*, which is spread over them, and from which they have a membrane like a *mesentery*, so hang loose and pendulous in the *abdomen*: Whereas in us they are con-

tained in the cellular part of the *peritoneum*, which is tensely stretched over them. At their passage out of the lower belly, there appears a plain perforation or holes; and from observing this in quadrupeds has arisen the false notion of *hernia* or *rupture* among authors. This opening is of no disadvantage to them, but evidently would have been to us, for from the weight of our *viscera* and our continually gravitating upon these holes, we must have perpetually laboured under *enterocele*; this they are in no hazard of, since in them this passage is at the highest part of their belly, and in their horizontal posture, the *viscera* cannot bear upon it! And to prevent even the smallest hazard, there is a loose pendulous semilunar flap of fat which serves two uses, as it both hinders the *intestines* from getting into the passage, and also the course of the fluids from being stopped in the vessels, which is secured in us by the cellular substance and tense *peritoneum*.

The *septum medium*, or conjunction of the two tunics, is the same as in men. There is next a passage quite down into the cavity, where the *testicles* lie. Had the same structure obtained in man, by the constant drilling down of the liquor which is secreted for the lubricating of the guts, we should always have laboured under an *hydrocele*; but their posture secures them from any hazard of this kind; indeed your very fat lap-dogs, who consequently have an overgrown *omentum*, are sometimes troubled with an *epiplocele*.

The *serotum* is shorter and not so pendulous as the Human, this it has in common with all the dog kind that want the *vesiculae seminales*, who have it pretty close tucked up, that the seed at each copulation might the sooner be brought from the *testes*, thus in some measure supplying the place of the *vesiculae seminales*; for the course of the seed through the *vasa deferentia* is thus shortened by placing the secreting vessels nearer the excretory organs. This at the same

same time explains the reason why this creature is so tedious in copulation.

The structure of the *testicles* is much the same with the human ; as are likewise the *corpus pyramidale varicosum* or *fampiniforme*, and the *epididymis* or excretory vessel of the *testicle* ; the *vasa deferentia* enter the *abdomen* where the blood vessels come out, and passing along the upper part of the bladder, are inserted a little below the bulbous part of the *urethra*.

The *præputium* has two muscles fixed to it ; one that arises from the *sphincter ani*, and is inserted all along the *penis*, and this is called *retractor præputii* ; but the other, whose office is directly contrary to this, is cutaneous, and seems to take its origin from the muscles of the *abdomen*, or rather to be a production of their *tunica carnosâ*. The *corpora cavernosa* rise much in the same way as the human ; but these soon terminate, and the rest is supplied by a triangular bone, in the inferior part of which there is a groove excavated for lodging the *urethra*. There are upon the *penis* two protuberant bulbous fleshy substances, at the back of which are two veins, which by the *erectores penis* are compressed in the time of coition, and the circulation being stopt, the blood distends the large *cavernous bodies* : After the *penis* is thus swelled, the *vagina*, by its contraction, gripes it closely, and so the male is kept in action some time contrary to his will, till time be given for bringing a quantity of seed sufficient to impregnate the female ; and thus by that *orgasmus veneris* of the female organs, the want of the *vesiculae seminales* are in some measure supplied. But as it would be a very uneasy posture for the dog to support himself solely upon his hinder feet, and for the bitch to support the weight of the dog for so long a time ; therefore as soon as the bulbous bodies are sufficiently filled, he gets off and turns averse to her ; had then the *penis* been pliable as in other animals, the *urethra* must of necessity have been compressed by this twisting, and

consequently the course of the seed intercepted ; but this is wisely provided against by the *urethra's* being formed in the hollow of the bone. After the emission of the seed, the parts turn flaccid, the circulation is restored, and the bulbous parts can be easily extended.

The *prostata* seems here divided into two, which are proportionally larger than the human, and afford a greater quantity of that liquid.

The *uterus* of multifarious animals is little else but a continuation of their *vagina*, only separated from it by a small ring or valve. From the *uterus* two long canals mount upon the loins, in which the *fœtus's* are lodged ; these are divided into different sacs, which are strongly constricted betwixt each *fœtus*, yet these coarctations give way in the time of birth. From these go out the *tubæ fallopiana*, so that the *ovaria* come to lodge pretty near the kidneys.

We ought next to examine the structure of the *thorax* and its contents ; but first it may not be amiss to remark of the *diaphragm* in its natural situation, that it is in general more loose and free than the human, which is owing to its connection with the neighbouring parts in a different manner from ours ; the human *diaphragm* is connected to the *pericardium*, which again by the intervention of the *mediastinum* is tied to the *sternum*, *spine*, &c. but here there is some distance between the *diaphragm* and *pericardium*. We observe further that its middle part is much more moveable, and the tendinous parts not so large. And indeed it was necessary their *diaphragm* should be somewhat loose, they making more use of it in difficult respiration than man. This we may observe by the strong heaving of the flanks of an horse or dog when out of breath, which corresponds to the riling of the ribs in us.

The disposition and situation of the *mamma* vary as they bear one or more young. Those of the uniparous kind have them placed between the posterior extremities, which in them is the highest part of their

their bodies; whereby their young get at them without the inconvenience of kneeling; nevertheless, when the creatures are of no great size, and their breast large, as in sheep, the young ones are to take this posture. In multifarious animals they must have a great number of nipples, that their several young ones may have room at the same time, and these disposed over both *thorax* and *abdomen*; and the creatures generally lye down when their young are to be suckled, that they may give them the most favourable situation. From this it does not appear to be from any particular fitness of the vessels at certain places, for giving a proper nourishment to the child, that the breasts are so placed in women, as we find them, but really from that situation being the most convenient, both for mother and infant.

The *sternum* is very narrow, and consists of a great number of small bones, moveable every way, which always happens in creatures that have a great mobility in their *spine*. The ribs are straighter and by no means so convex as the human, whereby in respiration the motion forward will very little enlarge their *thorax*, which is compensated by the greater mobility of their *diaphragm*: so our *thorax* is principally enlarged according to its breadth and depth, and theirs according to its length. The want of *clavicles*, and the consequent falling in of the anterior extremities upon the chest, may contribute somewhat to the straightness of the ribs.

The *mediastinum* in this creature is pretty broad, whereas the human being so narrow has occasioned a dispute whether there be such a thing or not. The *pericardium* is not here contiguous to the *diaphragm*, but there is an inch of distance betwixt them, in which place the small lobe of the lungs lodges, and by this means the liver, &c. of this animal, though continually pressing upon the *diaphragm*, yet cannot disturb the heart's motion.

The heart is situated with its point almost directly downwards, according to the creature's posture, and

is but very little inclined to the left side. Its point is much sharper, and its shape more conoidal than the human. Here the names of right and left *ventricles* are proper enough, though not so in the human, which ought rather to be called anterior and posterior, or superior and inferior. The animal has the *vena cava* of a considerable length within the *thorax*, having near the whole length of the heart to run over ere it gets at the *sinus lowerianus dexter*. In men, as soon as it pierces the *diaphragm*, so soon it enters the *pericardium*, which is firmly attached to it, and immediately gets into the *sinus lowerianus*; which *sinus* in the human subject, by the oblique situation of the heart, is almost contiguous to the *diaphragm*, and by this we discover that several authors have taken their delineations of the human heart from brutes, which is easily detected by the shape and situation of the heart, and long *vena cava* within the *thorax*. This was one of the faults of the curious wax works, that were shewn at London and Paris, which was plainly taken from a cow.

This situation of the heart of the creature agrees best with the shape of its *thorax*, which is lower than the *abdomen*.

The egress of the large blood-vessels from the heart is somewhat different from the human, for here the left *subclavian* comes off first, and then a large trunk runs some way upwards before it gives off the left *carotid*, and splits into the *carotid* and *subclavian* of the right side: So that neither here, properly speaking, is there an *aorta ascendens*, more than in the human, but this name has probably been imposed upon it from observing this in a cow, where indeed there is an ascending and descending *aorta*.

From this speciality of the distribution of the vessels of the right side, which happens, though not in so great a degree, in the human subject, we may perhaps in some measure account for the general greater strength, readiness or faculty of motion which is observable in the right arm. I believe upon measuring

measuring the sides of the vessels, the surface of the united trunk of the right *subclavian* and *carotid* is less than that of the left *subclavian* and *carotid*, as they are separated ; if so, the resistance to the blood must be less in that common trunk, than in the left *subclavian* and *carotid* ; but if the resistance be smaller, the absolute force with which the blood is sent from the heart being equal, there must necessarily be a greater quantity of blood sent through them in a given time. And as the strength of the muscles is, *ceteris paribus*, as the quantity of blood sent into them in a given time, those of the right-arm will be stronger than those of the left. Now children being conscious of this superior strength, use the right upon all occasions, and thus from use comes that great difference which is so observable. That this is a sufficient cause seems evident from fact ; for what a difference is there betwixt the right and left-arm of one who has played much at tennis ? view but the arms of a blacksmith, and legs of a foot-man, and you'll soon be convinced of this effect arising from using them. But if by any accident the right-arm is kept from action for some time, the other from being used gets the better, and those people are left handed : For it is not to be imagined that the small odds in the original formation of the vessels should be sufficient to resist the effect of use and habit, (instances of the contrary occur every day;) 'tis enough for our present argument that where no means are used to oppose it, the odds are sufficient to determine the choice in favour of the right. Now because it is natural to begin with the leg corresponding to the hand we have most power of ; this is what gives also a superiority to the right leg.

This difference is not peculiar to man, but is still more observable in those creatures, in whom the same mechanism does obtain in a greater degree. Do but observe a dog at a trot, how he bears forwards with his right side, or look at him when a-scraping up any thing, and you will presently see that he uses his right

right much sooner than he does his left foot. Something analogous to this may be observed in horses.

The *thymus* of this creature is proportionably much larger than ours, whereas the *glandula thyroidea*, is much less, and it is generally remarked, that these two glands do thus always supply the place of each other: that is, in such animals as have a large, *thymus*; the *glandula thyroidea* is smaller, and *vice versa*. Hence we are naturally led to ascribe the same use to both, *viz.* the separation of a thin *lymph*, for diluting the *chyle* in the *thoracic duct*, before it be poured into the blood; then if we consider the different formation of the *thorax* in both, we shall readily account for the variety in the bulk of these two glands. Respiration being chiefly performed in man by the widening of the chest, the lungs at every inspiration must press upon the *thymus*, and consequently diminish it; but the *diaphragm* yielding more in the dog's inspiration, this gland is not so much pressed by the lungs, and so will be larger, and hence the *glandula thyroidea* will be proportionably less: Again, from the posture of this creature, we shall see that it was much more convenient for a dog to have the most part of the diluting *lymph* supplied by the *thymus*, since the neck being frequently in a descending posture, the *lymph* of the *thyroid* gland would have a very disadvantageous course to get to the *thoracic duct*: whereas in the human body, the *thymus* is really below the *lacteal* canal, where it makes its curvature before it opens into the *subclavian*, and consequently there is a necessity of a considerable share of the diluting liquor being furnished by the *thyroid* gland, which is situated much higher, so that its *lymph* has the advantage of a perpendicular descent.

We may here observe, that the *thoracic duct* in a dog has no curvature before it enters the *subclavian* vein. The horizontal position of this animal allowing a favourable enough course to the *chyle*, so as not to need that turn to force its passage into the blood. The lungs of this creature are divided into more numerous

merous lobes and deeper than they are in man, for the same reason as the liver. The left side of the thorax in this animal bears a greater proportion to the right than in man, the one being nearly as three to two, the other as four to three.

We look on it as a general rule, that all quadrupeds, as having occasion to gather their food from the ground, are provided with longer necks than man; but as a long neck not only gives the advantage of too long a lever to the weight of the head, but also when the animal is gathering his food, makes the brain in danger of being oppressed with too great a quantity of blood, by the liquor in these arteries having the advantage of a descent, while that in the veins must remount a considerable way contrary to its own gravity, it was therefore necessary that a part of the length of the neck should be supplied by the length of the jaws. Thus we see horses, cows, &c. who have no occasion for opening their mouths very wide, yet have long jaws. Bull dogs indeed, and such animals as have occasion for very strong jaws, must of necessity have them short; because the longer they are, the resistance to be overcome acts with a longer lever. Another exception to this general rule is, such animals as are furnished with something analogous to hands to convey their food to their mouths, as cats, apes, &c. The teeth of this creature plainly shew it to be of the carnivorous kind, for there are none of them made for grinding their food, but only for tearing and dividing it. Even its posterior teeth are not formed with rough broad surfaces as ours are; but are made considerably sharper, and press over one another when the mouth is shut, that so they may take the firmer hold of whatever comes betwixt them.

The tongue, in consequence of the length of the jaws, is much longer than ours; and as this creature feeds with his head in a depending posture, the *bolus* would always be in danger of falling out of the mouth, were it not for several prominences placed mostly

mostly at the root of the tongue, and crooked backwards in such a manner, as to allow any thing to press easily down to the jaws, but to hinder its return. In some animals who feed on living creatures, these under hooks are still more conspicuous, as in several large fishes, where they are almost as large as their teeth in the fore part of their mouth, and near as firm and strong.

When we open the mouth, we see the *amygdals* very prominent in the posterior part of it, so that it would appear at first view, that these were inconveniently placed, as being continually exposed to injuries from the hard substances this creature swallows; but upon a more narrow scrutiny we find this provided for by two *membranous capsulae*, into which the *amygdals*, when pressed, can escape and remove themselves from such injuries.

The *velum pendulum palati*, is in this creature considerably longer than in man, to prevent the food from getting into his nose; which would happen more frequently in this animal than in man, because of its situation while feeding.

In this subject there is no *uvula*, but then the *epiglottis*, when prest down, covers the whole *rima* entirely, and naturally continues so; there is therefore a ligament or rather muscle that comes from the *os hyoides* and root of the tongue that is inserted into that part of the *epiglottis*, where it is articulated with the *cricoid cartilage* which serves to raise it from the *rima*, though not so strongly but that it may with a small force be clapt down again. If then in all such animals as have no *uvula*, the *epiglottis* is so ordered as to be capable of covering the *rima* entirely, and if in man the *epiglottis* cannot be so prest backwards and downwards, as to shut up the *glottis* perfectly, but leaves a space that can be exactly filled up by the *uvula*, we may very reasonably conclude that the use of this part is to supply this deficiency in the *epiglottis*.

In

In the upper part of the *pharynx*, behind the *cri-*
coid cartilage, there is a pretty large gland to be
found, which serves not only for the separation of a
mucous liquor, to lubricate the *bolus* as it passes this
way, but also supplies the place of a *valve*, to hinder
the food from regurgitating into the mouth, which it
would be apt to do by reason of the descending situ-
ation of the creature's head.

The *œsophagus* is formed pretty much in the same
way as the human; authors indeed generally allege,
that *quadrupeds* have their gullet composed of a
double row of *spiral fibres* decussing one another, but
this is proper to ruminating animals, who have occa-
sion for such a decussation of *fibres*. The action of
these you may easily observe in a cow chewing her
cud.

The nose is generally longer than in man, and its
external passage much narrower. The internal
structure is also better adapted for an acute smelling,
having a larger convoluted surface on which the
membrana scheideriana is spread, and this is to be ob-
served in most *quadrupeds*, who have the *ossea spongiosa*
commonly large, and these too divided into a great
number of excessively fine thin *lamellæ*. The ele-
phant, which has a head pretty large in proportion
to its body, has the greatest part of it taken up with
the cavity of the nose and *frontal sinusses*, which last
extend almost over their whole head, and leaves but a
small cavity for their brains. A very nice sense of smel-
ling was not so absolutely necessary for man, who has
judgment and experience to direct him in the choice
of his food; whereas brutes, who have only their
senses, must have these of necessity acute, some having
one sense in greater perfection than others, according
to their different way of life. We not only conclude
a priori from the large expanded *membrana scheide-*
riana that their sense of smelling is very acute, but
we find it so by cows and horses distinguishing so
readily betwixt noxious and wholesome herbs, which
they do principally by this sense.

The external ear in different *quadrupeds* is differently framed, but always calculated to the creature's manner of life: In shape it commonly resembles the oblique section of a *cone* from near the *apex* to the *basis*. Hares and such other animals as are daily exposed to insults from beasts of prey, have large ears directed backwards, their eyes warning them of any danger before; rapacious animals, on the other hand, have their ears placed directly forwards, as we see in the lion, cat, &c. The slow hounds and other animals that are designed to hear most distinctly the sounds coming from below, have their ears hanging downwards. Man again, who must equally hear sounds coming from all quarters, but especially such as are sent from about his own height, has his external ear placed in a *vertical* manner, somewhat turned forward. In short, wherever we see a speciality in the make of this organ in any creature, we shall with very little reflection discover this form to be more convenient for that creature than another. There are some differences to be observed in the structure of the internal ear in different animals; but we know so very little of the use of the particular parts of that organ in the human subject, that it is altogether impossible to assign reasons for these variations in other creatures.

All *quadrupeds* have at the internal *canthus* of the eye, a strong firm *membrane* with a *cartilaginous* edge, which may be made to cover some part of their eye, and this is greater or less in different animals, as their eyes are more or less exposed to dangers in searching after their food: this *membrana nictitans*, as it is called, is not very large in this animal; cows and horses have it so large as to cover one half of the eye like a curtain, and at the same time is transparent enough to allow abundance of the rays of light to pass through it; fishes have a *cuticle* always over their eyes, as they are ever in danger in that inconstant element. In this then we may also observe a sort of gradation.

All

All quadrupeds have a seventh muscle belonging to the eye, called *suspensorius*. It surrounds almost the whole *optic nerve*, and is fixed into the *sclerotic coat* as the others are; its use is to sustain the weight of the globe of the eye, and prevent the *optic nerve* being too much stretched, without obliging the four straight muscles to be in a continual contraction, which would be inconvenient. At the same time this muscle may be brought to assist any of the other four, by causing one particular portion of it to act at a time.

The next thing to be remarked is the figure of the pupil, which is different in different animals, but always exactly accommodated to the creature's way of life. Man has it circular for obvious reasons; an ox has it transverse, to take in a larger view of his food; cats again have theirs somewhat perpendicular, (but can alter it pretty much) for a similar reason, and so of the rest: the pupil of different animals varies in wideness, according as the internal organs of vision are more or less acute; thus cats and owls who seek their prey in the night, or in dark places, (and consequently must have their eyes so formed as that a few rays of light may make a lively impression on the *retina*), have their pupils in day time contracted into a very narrow space, as a great number of rays would oppress their nice organs, while in the night they dilate considerably. In the same way when the *retina* is inflamed, a great number of rays of light would occasion a painful sensation, therefore the pupil is contracted; on the contrary, in dying people, or in a beginning *amaurosis*, it is greatly dilated, as the eyes on such occasions are very difficultly affected, and as it were insensible.

The posterior part of the *choroid coat*, which is called *tapetum*, is of different colours in different creatures. Oxen feeding mostly on grass have this membrane of a green colour, that it may reflect upon the *retina* all the rays of light which come from objects of that colour, while other rays are obscured: thus the animal sees its food better than other objects.

Cats and owls have their *tapetum* of a whitish colour, and for the same reasons have the pupil very dilatable, and their organs of vision acute; and we shall find that all animals see more or less distinctly in the dark, according as their *tapetum* approaches nearer to a white or black colour. Thus dogs who have it of a greyish colour distinguish objects better in the night than man, whose *tapetum* is dark brown, and who, I believe, sees worst in the dark of any creature, it being originally designed that he should rest from all kinds of employments in the night time. The difference then of the colour of the *tapetum*, as indeed the fabric of any other part in different creatures, always depends on some particular advantage accruing to the animal in its peculiar manner of life from this singularity.

We shall now proceed to the brain, which we remark in the first place is proportionally much smaller in all *quadrupeds* than the human. The reason of which may be, that as those creatures for the most part seek their food with their heads in a depending posture, this situation would make it very inconvenient for the brain itself to send its animal spirits (or its influence and energy, let that be what it will) through the nerves, so that it was necessary they should be supplied from somewhere else, and consequently there was no reason for the brain itself being of a great bulk. As a confirmation of this theory, we find that the *intercostal* and eight pair of nerves, which serve the vital organs in the human body, take their origin from the *encephalon*, which in *quadrupeds* come mostly from the *theca vertebrarum*. Again, there was no such occasion for so great a quantity of brains in those animals as in man; seeing in them all its energy is employed in their progression, while man has great waste of spirits in the exercise of his reason and intellectual faculties. And besides all this, a great bulky brain would be inconvenient to these creatures, in so far as it would add considerably to the weight of the head, which having the advantage

a long *lever* to act with, would require a much greater force to support it than now it does; for the heads of the greatest parts of *quadrupeds* are not near so heavy as they would at first seem to be, from the *sinus frontales* being produced a great way upwards to enlarge the organs of smelling.

The pits in the anterior part of their skulls are much more conspicuous than in the human *cranium*, which may be occasioned by the depending posture of these creatures heads, while they gather their food: The brain at this time gravitating much on the bones while they are as yet soft, will gradually make impressions upon them at these places where it rises into eminencies. This is prevented in man mostly by his erect posture.

The *falx* is not near so large in *quadrupeds* as in man, as they have little occasion to be on either side, and the two *hemispheres* of the brain are in a great measure hindered from jostling against one another in violent motions, by the brain's insinuating itself into the above-mentioned pits.

The second process of the *dura mater*, or *tentorium cerebello superexpansum*, is considerably thicker and stronger in most *quadrupeds* than in man, especially in such of them as are very swift of foot, as hares and rabbits, and that most when they are old. This membrane is generally ossified, that it may the more effectually keep off the weight of the superincumbent brain from the *cerebellum* in their rapid motions, which otherwise would be of bad consequence.

The olfactory nerves are very large, and justly deserve the name of *processus mamillaris*. They are hollow, and consist of a *medullary* and *cineritious* substance, and at first sight appear to be anterior ventricles of the brain produced; but in man they are small, and without any discernable cavity. The reason of this is pretty evident, if we consider how this animal's head is situated; for the *lymph* continually gravitating upon the inferior part of the *ventricles* may thus elongate and produce them: But from this

very inferior part the *olfactory nerves* rise, and are sent immediately through the *os ethmoides* into the nose. Hence the antiquits thinking they were continued hollow into the nose, believed they were the emunctories of the brain; in the brain of sheep which by its firm texture is the best subject of any for searching into the structure of this part, we evidently see, that the name of the *sigmoid* cavities was very properly applied by the antiquits to the lateral ventricles of the brain, which are really of a greater extent than they are ordinarily painted by the anatomists, reaching farther backwards and forwards again under the substance of the brain.

The *nates* and *testes* deserve this name much better here than in the human body with respect to each other. They are here also of different colours, the *nates* being of the colour of the *cortical*, and the *testes* of the *medullary* substance of the brain: Whereas in man they are both of one colour. The reason of these differences, and others of the like nature to be met with, I shall not pretend to determine; for we have hitherto such an imperfect knowledge of the brain itself, that we are entirely ignorant of the various uses of its different parts; we may in general conclude, that the varying in one animal, from what it is in another, is fitted to the creature's particular way of living.

The *rete mirabile galeni*, situated on each side of the *sella turcica*, about which there has been so much dispute, is more remarkable in *quadrupeds* than in the human subject, though it is certainly to be found there too; notwithstanding several anatomists have denied its existence. The use indeed which Galen ascribes to it is frivolous, and not well grounded; for he will have this *plexus* of the vessels serve for checking the impetuosity of the brain, but it is evident this cannot be the use of it; if indeed the whole *carotid artery* had split into such small vessels as compose this network, the motion of the blood would certainly have been retarded in it; but this is not the case, for it

only

only sends off a few small twigs to compose the *plexus* at its entry into the *cranium*, and the branches going out from this same *plexus*, are distributed to the neighbouring nerves: Among the rest it gives some twigs to the *ophthalmic* branch of the fifth pair. It is this distribution of these arteries makes it so difficult to determine whether there is a communication between the *intercostal* and that nerve; for if you dissect the parts in a recent subject, you would at first view affirm, that there is an *anastomosis*; but when the *carotid artery* is injected, and the *plexus* filled with the subtle liquor, these branches, which formerly seemed to be nerves, have now the appearance of arteries by the vessels of their coats being injected. I have been at great pains to enquire into the matter, but could never positively determine if there is such an *anastomosis* as is described by a great many authors, and so very distinctly delineated by Dr Lower in Willis's treatise of the nerves, and Mr Vieussen, only it seems most probable from the sympathy observable between them that there is such an *anastomosis*.

The structure of the brain differing but very little in all *quadrupeds*, it will be needless to examine it in any other.

The Anatomy of a Cow.

THE next species of *quadrupeds* we proposed to consider was the ruminant kind, of which we have an example in a cow, and accordingly shall take the *fœtus* of the animal in *utero*, that we may first remark some things that are peculiar to it in that state, and afterwards proceed to examine its *viscera* as a ruminant animal; first then as a *fœtus*:

The form of a cow's *uterus* differs from the human, in having two pretty large *cornua*. This is common to it with other brutes, for a bitch has two long *cornua uteri*; but these again differ (as being multi-

parous

parous and *uniparous*) in this, that in the bitch's *uterus* the *fœtus's* are contained, whereas here there is only part of the *secundines*, being mostly the *allantois* with the included liquor. The muscular fibres of the *uterus* are more easily discovered; its internal surface has a great number of spungy, oblong, protuberant, glandular bodies fixed to it by a fine *membrane*: These are composed of several large vessels of the *uterus* terminating here. These are very small, and sometimes not to be observed at all. In an impregnated *uterus* we can easily press out of them a *chylous mucilaginous* liquor; they are composed of a great many processes or *digituli*, and deep caverns answering to as many processes and caverns of the *placenta*. Their resemblance has occasioned the name of *papilla* to be given them, and hence it was that Hippocrates was induced to believe, that the *fœtus* suck'd in *utero*. It is not easy to determine, whether the *uterus* grows thicker or thinner in the time of gestation. The *membranes* it is plain (by the stretching of the parts) must be made thinner, but then it is as evident, that the vessels are at that time enlarged, upon which principally the thickness of any part depends; so there seems to be as much gained the one way, as lost the other. The *os uteri* is entirely shut up by a glutinous mucilaginous substance, that is common to the females of all creatures when with young; by this the external air is excluded, which would soon make the liquors corrupt; it also prevents the inflammation of the *membranes*, and the hazard of abortion. By this means also the lips of the womb are kept from growing together, which otherwise they would certainly at this time do. There are *mucous* glands placed here to seern this *gluten*, which on the breaking of the *membranes* with the contained waters make a *sapo* that lubricates and washes the parts, and makes them easily yield. The first of the proper *involutura* of the *fœtus* is the *chorion*.

The *chorion* is a pretty strong firm *membrane*, on whose external surface are dispersed a great many red fleshy

fleshy bodies of the same number, size and structure with the *papillæ*, with which they are mutually indented. They have been called *cotyledones* from ~~uteri~~ cavity. This is greatly disputed by some as a name very improper, but I think without reason, since the surface that is connected to the *papilla* is concave, though when separated it appears rather convex. To shun all dispute, they may be called properly enough *placentulae*, since they serve the same use as the *placenta* in women. The separation of these from the *papilla* without any dilaceration seems to prove beyond a reply, that there can be here no *anastomoses* betwixt the vessels; on their coats run a great number of vessels that are sent to the several *placentulae*, on the external side next to the *uterus*; whereas in creatures that have but one *placenta*, as in the human subject, cats, dogs, &c. the adhesion is somewhat firmer: The *placentæ* are likewise joined to the *papilla* in the *cornua uteri*. We shall next give the history of the *allantois*.

This is a fine transparent membrane contiguous to the former. It is not a general *involutum* of the *fœtus* in the mother, for it covers only a small part of the *amnios*: It is mostly lodged in the *cornua uteri*. In mares, bitches and cats it surrounds the *amnios*, being every where interposed betwixt it and the *chorion*. In sheep and goats it is the same as in this animal; and in swine and rabbits it covers still less of the *amnios*. This sac is probably formed by the dilatation of the *urachus*, which is connected at its other end to the *fundus* of the bladder, through which it receives its contents, and the *membrane* is doubled at the extremity of the canal to hinder the return of the urine back into the bladder. Its vessels are excessively fine and few, and we cannot force an injected liquor farther than the beginning of this coat. This *membrane* is so far analogous to the *cuticula*, as not to be liable to corruption, or easily irritated by acrid liquors. The existence of this *membrane* in women has been very warmly disputed on both

both sides : Those who are against its existence deny they could ever find it, and allowing it were so, allege, that since the *urachus* is impervious, as appears by our not being able to throw liquors from the bladder into it, or *vice versa*, it cannot serve the use that is agreed by all it does serve in beasts, and therefore in the human body there is no such thing : But if we consider on the other hand, that first there seems to be the same necessity for such a reservoir in man as in other animals. Secondly, that we actually find urine contained in the bladder of the human *fœtus*. Thirdly, that urine has been evacuated at the navel when the *urethra* was stopped, which urine without this conduit would have fallen into the cavity of the *abdomen*. Fourthly, that midwives do generally remark two different sorts of waters come away at the time of birth. And, lastly, that Dr Littre and Dr Hale have given in this *membrane* of an human subject with all the other secundines curiously prepared, the one to the Royal Academy at Paris, the other to the Royal Society at London, by which societies their respective accounts are attested, not to mention Verheyen, Heister, Keil, &c. who affirm their having seen it, and Mr Albinus, that famous anatomist, professor at Leyden, shows, as I am told, to his college every year a preparation of it. On all these accounts I must own, that it seems most probable to me there is such a *membrane* in the human body, although in four bodies I purposely dissected, wherein I was assisted by a very accurate anatomist, Dr S——r, I could not observe any such thing ; however, I would rather accuse my own want of skill, than doubt the truth of relations supported by such authentic vouchers.

The third proper integument of the *fœtus* is the *amnios* ; it is thinner and firmer than the *chorion* ; it has numerous ramifications of the umbilical vessels spread upon it, the lateral branches of which separate a liquor into its cavity. This is the proper liquor

quor of the *amnios*, which at first is in a small quantity, afterwards increases for some months, then again decreases ; and in a cow near her time the quantity of this liquor is not above a pound. This membrane does not enter the *cornua uteri* in this creature ; but for what further relates to the structure of the *involucra*, with the nature of the liquors contained in them, I must refer to the second volume of medical essays, from page 121, where you have the sum of all we know of this matter.

There are here two *venae umbilicales*, and but one in the human subject, because the extreme branches coming from the several *placentulae* could not unite so soon as they would have done had they come all from one cake, as in the human.

There is a small round fleshy body that swims in the urine of this creature, mares, &c. called *cuticula*, which is the *bypomenes* of the ancients. Several idle opinions and whims have been entertained as to its use, but that seems to be still unknown, or how it is generated or nourished, for it has no connection with the *fœtus* or *placentula*.

Having thus considered the several *involucra* of this animal in a *fœtus* state, let us next observe the specialities in its internal structure peculiar to a *fœtus*.

The umbilical vein joins the *vena portarum* in the *capsula glissoniana* without sending off any branches as it does in the human subject. This vein soon after birth turns to a ligament, yet there are some instances where it has remained pervious for several years after birth, and occasioned an hemorrhage. We may next observe the duct called *canalis venosus*, going straight from the *capsula glissoniana* to the *vena cava* ; this turns also afterwards to a ligament. The umbilical arteries rise at acute angles from the internal iliacs, whatever some may say to the contrary. These also become impervious.

The pulmonary artery coming from the right ventricle of the heart, divides into two, the smallest called

called *canalis arteriosus* opens into the descending *aorta*; the other divides into two, to serve the lungs on each side. The *foramen ovale* is placed in the partition betwixt the right and left auricles. At the edge of this hole is fixed a *membrane*, which when much stretched will cover it all over, but more easily yields to a force that acts from the right auricle to the left, than from the left to the right. After what has been said we may easily understand how the circulation is performed in a *fœtus*. The blood being brought from the *placenta* of the mother, is thrown into the *capsula glissoniana*, where it is intimately blended with the blood in the *vena portarum*: then part of this blood goes directly into the *vena cava* by the *ductus venosus*, the rest passes through the liver. First then, the whole is sent from the *vena cava* into the right auricle, from whence part of it is sent by the *foramen ovale* into the left auricle, the rest passes into the right ventricle, then into the pulmonary artery, then the greatest share it receives is sent immediately into the descending *aorta* by the *canalis arteriosus*, and the remainder circulates through the lungs and is sent back by the pulmonary veins into the left auricle, which with the blood brought there by the *foramen ovale* is sent into the left ventricle, from whence it is driven by the *aorta* through the body. The great design of this mechanism is, that the whole mass of blood might not pass through the collapsed lungs of the *fœtus*, but that part of it might pass through the *foramen ovale* and *canalis arteriosus* without circulating at all through the lungs.

This was the opinion that universally prevailed till the end of the last century, when it was violently opposed by Monsieur Mery, who is very singular in several of his opinions. He will not allow that the *foramen ovale* transmits blood from the right to the left auricle, but, on the contrary, from the left to the right, and that for no other reason but because he observed the pulmonary artery in a *fœtus* longer

longer than the *aorta*: Mr Winslow endeavours to reconcile these two opinions, by saying the blood may pass either way, and that it is here as it were blended; his reason is, that on putting the heart in water, the *foramen ovale* transmits it any way. Mr Rohault, professor of anatomy at Turin, and formerly one of Mery's scholars, strongly defends his master and criticises Mr Winslow. What he principally builds on is the appearance this *foramen* has in some dried preparations: This Mr Winslow won't allow as a proof. After all I remain in the common opinion, and that for the following reasons: First, the *pulmonary artery* being larger signifies nothing, since its coats are not only thinner, and will be more easily distended, but also the resistance to the blood in the *pulmonary artery* from the collapsed lungs is greater than the resistance to the blood in the *aorta*. Secondly, if we should allow any of these two uncommon opinions, we should have the right ventricle vastly more capacious than the left; for if we suppose the *foramen ovale* to be capable of transmitting one half of the whole mass of blood in any given time, and the *arteriosus* as much in the same time, then you'll find that, according to Mr Mery's opinion, the whole mass of blood being driven from the right ventricle into the *pulmonary artery*, one third passes by the *canalis arteriosus* into the descending *aorta*, two thirds passing through the lungs and returning into the left auricle, one half of it, or one third of the whole mass, passes by the *foramen ovale* into the right auricle, and the other or the last third will be sent into the left ventricle, and thence expelled into the *aorta*, which third, with that from the *pulmonary artery* by the *canalis arteriosus*, circulating through the body, are returned unto the right auricle, where meeting with the other third from the *foramen ovale*, with it are sent into the right ventricle to undergo the same course. Thus the whole mass is expelled by the right ventricle and only one third by the left. If

was the case, why is not the right ventricle three times as large and strong as the left? Then if according to Mr Winslow's system the *foramen ovale* transmits equal quantities from both *auricles*, this comes to the same as if there were no *foramen ovale* at all; that is to say, the whole mass going from the right *auricle* into the right ventricle and *pulmonary artery*, one third of the whole mass passes into the *aorta* through the *canalis arteriosus*, the other two thirds passing through the lungs return to the left ventricle and *auricle*, to be sent through the *canalis arteriosus* to the right ventricle to undergo the same fate; thus the right ventricle expels the whole mass, the left only one third; but if according to the common opinion we suppose the *foramen ovale* to convey the blood from the right to the left *auricle*, then one third passes this way into the left ventricle, the other two thirds are sent by the right ventricle into the *pulmonary artery*, from whence one third passes by the *canalis arteriosus* into the *aorta descendens*, the other third circulates through the lungs, and is returned into the left ventricle, where meeting with that from the *foramen ovale* is with it expelled into the *aorta*, and with the one third transmittted by the *canalis arteriosus* returns into the *auricle* to run the same race as before. Thus we conclude that two thirds are expelled by each ventricle and the whole circulates through the body; and hence they come to be of pretty equal dimensions. In all this calculation I have had no regard to the blood discharged from the *umbilical vessels*; but the greater quantity returned by the veins, than sent out by the arteries, still argues for the common opinion.

The kidneys in the *fætus* are composed of different lobes, which serves to give us an idea of the kidneys being a congeries of different glands; these lobes being kept contiguous by the external membrane are pressed by the other *viscera* till at length they unite.

We

We come now to consider the creature as a ruminant animal. There are no *dentes incisores* in the upper jaw, but the gums are pretty hard, their tongue rough, and they supply this defect by wrapping their tongue round a tuft of grafts, so pressing it against the upper jaw keep it stretched, and cut it with the teeth of the under jaw; then, without chewing, throw it down into the *aesophagus*, which, in these creatures, consists of a double row of *spiral fibres* decussating one another. All animals which ruminate must have more ventricles than one, some two, some three, our present subject has no less than four. The food is carried directly down into the first, which lies upon the left side and is the largest of all; it is called *νάσον ventriculus*, and *κοιλία* by way of eminence. It is what is called by the general name of paunch by the vulgar. There are no *rugae* upon its internal surface; the food, by the force of its muscular coat, and the liquors poured in here, is sufficiently macerated, after which it is forced up hence by the *aesophagus* into the mouth, and there it is made very small by mastication; this is what is properly called chewing the cud or ramification; after this it is sent down by the gullet into the second, for the *aesophagus* opens indifferently into both; however the creature has a power to direct it into which it will. Some tell us that the drink goes into the second, but that might be easily determined by making them drink before slaughter; the second stomach, which is the anterior and smallest, is called *κεχεύφαλος reticulum*, the *bonnet*, or *king's-hood*. It consists of a great number of cells on its internal surface of a regular *pentagonal figure*, like to a honeycomb. Here the food is farther macerated, from which it is protruded into the third, called *χιτόν* or *omasum*, *vulgo* the *manyplus*, because the internal surface rises up into a great many *plicæ* or folds, and *stratum super stratum*, according to the length of this stomach. Some of these *plicæ* are further produced into the stomach than others, i. e. first two long ones

ones on each side, and within these, two shorter in the middle, &c. There are several glands in this stomach which is next to the *vesica* in bigness; and from this it passes into the fourth, whose names are, *muscov abomasum*, *caille*, or the *red*, which is the name it commonly has because of its colour. *Caille* signifies curdled, and hence the French have given that as a name to this fourth stomach, because any milk that is taken down by young calves, from the long *remora* it makes here, turns acid; and by the remains of the milk before taken down assiting, it is curdled. It is this fourth stomach with the milk curdled in it, that is commonly taken for earning of milk (as they call it), but after the *bile* and *pancreatic* juice enter, this coagulation is not to be found which shews the use of these liquors. There are other creatures that use the same food, that have not such a mechanism in their digestive organs; horses, asses, &c. have but one stomach where grass is macerated, and a liquor for their nourishment extracted, and the remainder sent out by the *anus* very little altered. From this different structure of the stomach in these creatures, a ruminant animal will be served with one third less food than another of equal bulk; graziers are sufficiently acquainted with this. The reason is, that ruminating animals have many and strong digestive organs; all their food is fully prepared and almost wholly converted into *chyle*, but a horse's stomach is not fitted for this, so that they require a much greater quantity of food to extract the same nourishment.

The guts of these creatures are of a considerable length in proportion to the bulk of the animal's body, and this confirms what we said formerly on the subject of the *intestines* of a dog, viz. that the length and capacity of the guts were different in different animals according to the nature of their food.

The *duodenum* is formed here much the same way as in a dog, and the general intention kept in view with regard to the mixture of the *bile* and *pancreatic*

tic lymph. The great guts here hardly deserve that name, their diameter differing very little from that of the small ones; but to compensate this, they are much longer proportionally than a dog's are, being convoluted in the same way as the small guts are. The cæcum is very large.

The spleen differs not much either in figure or situation from that of a dog's, but it is a little more firmly fixed to the diaphragm, there not being here so much danger of this viscus's being hurt in the flexions of the spine.

The liver is not split into so many lobes in this creature as either in a man or dog, which depends on the small motion this creature enjoys in its spine, which made such a division needless: This also confirms what I formerly advanced on this head.

Their vesica urinaria is of a pyramidal shape, and has scarce any muscular fibres. It is very large and membranaceous, for the urine of these creatures not being so acrid as that of carnivorous animals, there was no such occasion for expelling it so soon.

This creature is provided with a loose pendulous scrotum, and consequently with vesicula seminales. The female organs differ from those of a bitch, mostly as to the form of the cornua uteri, which are here converted in form of a snail. In this and all uniparous animals they contain only part of the secundines, but in bitches and other multiparous animals they run straight up in the abdomen, and contain the fœtus themselves.

The situation of the heart is pretty much the same with that of a dog, only its point is rather sharper; in us the heart beating continually against the ribs, and both ventricles going equally far down to the constitution of the apex it is very obtuse, but here the apex is made up only of the left ventricle, so is more acute.

The aorta in this creature is justly divided into a scending and descending, though this division is ill founded either in a dog or man, and it has certainly

been from this subject that the older anatomists took their descriptions when they made this division; for here the *aorta* divides into two, the ascending and descending; the descending runs upwards or forwards, according to their posture, for two or three inches, before it gives off the left *subclavian*, and still an inch or more before the right *subclavian* comes off, and yet somewhat further before it divides into the two *carotids*, so that the vessels that go to the anterior extremity of the right-side, do still keep longer in a common trunk with the *carotids* than those on the left.

Of Fowls in general.

THE next class of animals we come to consider, are the feathered kind; which are divided into the *Granivorous* and *Carnivorous*. But before we go on to consider the specialties in the *viscera* of each kind, we must observe what both species agree in.

Fowls have a particular covering of *feathers* different from all other creatures, but exactly well suited to their manner of life; for it not only protects them from the injuries of the weather, but serves them in their progression through that thin aerial element, they are for the most part employed in; and as some fowls live much in the water, their feathers being continually besmeared with an oily liquor, keeps the water from soaking into their skins, and so prevents its bad effects, which it would infallibly otherwise produce.

Fowls have the strongest muscles of their whole body inserted into their wings; whence by the way we may observe that it is altogether impossible for man to buoy himself up into the air like birds, even though he had proper machines in place of wings, unless he were likewise provided with muscles strong enough for moving them, which he has not. In the next place their wings are not placed in the middle

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of their bodies, but a good deal further forwards, whence it would at first view appear that their heads would be erect, and their posterior parts most depending, when raised in the air; but by stretching out their heads, which act upon the *lever* of a long neck, they alter their center of gravity pretty much, and also by filling the sacs or bladders in the inside of their *abdomen*, with air, and expanding their tail, they come to make the posterior part of their bodies considerably higher, and thus they fly with their bodies near in an horizontal situation. Hence we find, that if their necks are kept from being stretched out, or if you cut away their tails, they become incapable of flying any considerable way. The largeness of the wings in different fowls varies, according to the occasions of the creature. Thus birds of prey, who must fly a considerably way to provide their food, have large strong wings; whereas domestic birds, who find their nourishment almost every where, have very short and but small wings. The best account of the manner of progression of fowls, is given by Alfonsus Borellus, in his treatise *De Motu Animalium*, and in the Religious Philosopher we have Borelli's doctrine stripped pretty much of its mathematical form. The posterior extremities are so situated as to make us at first think they would be in continual hazard of falling down forwards when they walk, but this is prevented by their holding up their heads and necks, and when they have occasion for climbing up a steep place, they stretch out their heads and necks forwards. Thus we may observe a goose entering a barn-door, where generally there is an ascending step, to stretch out its neck, which before was raised, and incline its body forwards; this is laughed at by the common people, who ascribe it to a piece of folly in the goose, as if afraid of knocking its head against the top of the door.

Carnivorous animals are provided with strong crooked claws for the catching their prey; water fowls use them for swimming, and principally for this purpose have a strong firm *membrane* interposed betwixt

twixt the toes. There is a beautiful mechanism to be observed in the toes of fowls; which is of considerable use to them; for their toes are naturally drawn together or bended when the foot is bended; this perhaps proceeds from the tendons of the toes passing over in them, which is analogous to our heels, and when the foot is bended must consequently be much stretched; and since they are inserted into the toes, must, of necessity bend them when the foot is bended, and when the foot is extended the *flexors* of the toes are again relaxed, and they therefore expanded. This is of great use to water fowls, for had there been no such contrivance as this, they must have lost as much time when they pulled their legs in, as they had gained by the former stroke; but as the parts are now framed, whenever the creature draws in its foot, the toes are at the same time bended and contracted into less space, so that the resistance made against the water is not near so great as before: On the contrary, when they stretch their foot, their toes are extended, the *membrane* betwixt them expanded, and consequently a greater resistance made to the water. Again, such fowls as live mostly in the air, or have occasion to sustain themselves on branches of trees in windy weather, and even in the night-time when asleep, while all their muscles are supposed to be in a state of relaxation; such, I say, have no more to do, but lean down the weight of their bodies, and their toes continue bended without any muscles being in action; and whenever they would disentangle themselves, they raise up their bodies, by which their foot, and consequently their toes, are extended.

Carnivorous fowls have their beaks long, sharp and crooked; the domestic fowls, such as the hen kind, &c. have strong short beaks, commodiously fitted to dig up and break their food; the water fowls again have long or very broad scoop like beaks, which is most convenient for them. The *sternum* of fowls is much larger proportionally than the human, and has

a ridge rising in its middle for the more commodious origin of the muscles that move the wings. It is also less moveable than ours, for had it been very moveable, a great deal of the force employed for moving the wings would at every contraction of the muscles have been lost, or else some other muscles must have come in play to keep firm the sternum, but this additional weight would have been inconvenient for their progression.

What other things are most remarkable in the structure of the several *viscera*, we shall consider in that common domestic animal, the cock or hen, and afterwards observe the difference of their *viscera chylopoietica* from a *carnivorous fowl*.

The Anatomy of a Cock.

TH E oesophagus of this creature runs down its neck somewhat inclined to the right-side, and terminates in a pretty large membranous *sac*, which is the *ingluvies* or crop where the food is macerated and dissolved by a liquor, separated by the glands which are easily observed every where on the external surface of this bag. The effect of this maceration may be very well observed in pigeons, who are sometimes in danger of being suffocated by the pease, &c. they feed upon, swelling to such an immense bulk in their *ingluvies*, that they can neither get upwards nor downwards. If it be a favourite fowl, it might be preserved by opening the *sac*, taking out the pease and sewing up the wound.

The food getting out of this *sac* goes down by the remaining part of the *oesophagus* into the *ventriculus succenturiatus* or *infundibulum peyeri*, which is a continuation of the gullet with more numerous glands, which separate a liquor to dilute the food still more, which at length gets into the true stomach or gizzard, which consists of two very strong muscles covered externally with a *tendinous aponeurosis*, and lined

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on the inside by a very thick firm *membrane*, which we evidently discover to be a production of the *cuticula*. This might have been proved in some measure *a priori*, from taking notice that this *membrane*, which in chicks is only a thin slight *pellicle*, by degrees turns thicker and stronger, the more attrition it suffers : but there is no other animal substance, so far as we know, which grows more hard and thick by being subjected to attrition, excepting the *cuticula*. Hence may be drawn some kind of proof of what I have sometimes affirmed concerning the *tunica villosa* of the stomach, and *intestines* in the human body, *viz.* that it was only a continuation of the *epidermis*. Nay, all the hollow parts of the body, even arteries, veins, &c. seem to be lined with a production of this *membrane* or one *analogous* to it. The use of this internal coat of the stomach of fowls is to defend the more tender parts of that *viscus* from the hard grains and little stones those creatures take down.

The digestion of these animals is performed merely by attrition, as is evinced by many experiments. We see them daily take down considerable numbers of the most solid rugged little flints they find, and these can serve for no other purpose than to help the trituration of their aliments. After these pebbles by becoming smooth are unfit for this office, they are thrown up by the mouth ; hence fowls that are long confined, though never so well fed, turn lean for want of these stones to help their digestion ; but this was put beyond all dispute by Mr Taurvry, who gave a species of metal to an ostrich, convex on one side, and concave on the other, but carved on both ; and opening the creature's body some time after, it was found that the carving on the convex side was all obliterated, while the engraved character remained the same as before on the concave side, which was not subjected to the stomach's pressure ; which could not have happened had digestion been performed by a *menstruum*, or any other way whatsoever ; but may be easily solved by allowing a simple mechanical pressure

pressure to take place. We are however by no means to conclude from this, as some have too rashly done, that in the human body digestion is performed by a simple attrition, otherwise we may with equal strength of reason, by as good arguments drawn from what is observed in fishes, prove that the aliments are dissolved in our stomachs by the action of a *menstruum*: But this method of reasoning is very faulty, nor can it ever bring us to the true solution of any philosophical or medical problem. It is very plain, since the structure of the parts of the human stomach are so very different from that of this creature, that it is foolish and unreasonable to imagine both of them capable of producing the same effects. At each end of the stomach there are as it were two particular sacs of a different texture from the rest of the stomach, not consisting of strong *muscular fibres*; they seem to be receptacles for the stones (especially at the end which is farthest from the orifice) while the digested aliment is protruded into the *intestines*.

The *duodenum* begins pretty near the same place, at which the *aesophagus* enters; yet notwithstanding the vicinity of these two tubes, the aliments are in no danger of getting out before they are perfectly digested, by reason of a protuberance or *septum medium* betwixt the orifices; and in those creatures who have such a strong muscular stomach, it is a matter of great indifference, whether the entry of the *aesophagus* or *pylorus* be highest, provided that the entry from the *aesophagus* does not allow the food to regurgitate, since the force of the stomach can easily protrude it towards the *duodenum*. This gut is mostly in the right side, and hangs pendulous in their *abdomen*, having its two extremities fixed to the liver. The *ductus communis choledochus* enters near its termination, where it mounts up again to be fixed to the liver; and lest, by the contraction of the *intestines*, the bile should pass over without being intimately blended with the *chyle*, that *duct* enters downwards contrary to the course of the food, and contrary to what is observed in

In any of the animals we have mentioned yet. But still the general intention is kept in view, in allowing these juices the fairest chance of being intimately blended with the food.

The small guts are proportionally larger than those of carnivorous birds, for the general cause already assigned. At the end of the *ilium* they have two large *intestina cæca*, one on each side, which serve as reservoirs to the *feces*, which after some *remora* there regurgitate into what soon becomes the *rectum*, which, together with the excretaries of the urine, and organs of generation, empties itself into the common *cloaca*. The small *intestines* are connected by a long loose *mesentery*, which has little or no fat accompanying the blood vessels, there being no hazard of the blood's being stopped. There are no lacteal vessels, *glandulae vagæ* or *pancreas affellii* to be observed here. The *meseraic veins* are proportionally very large, if you either compare them with the corresponding arteries, or consider them with respect to the guts themselves. The want of lacteals, &c. is supplied by these veins. As a proof of these having a communication with the guts, in larger fowls the guts can be distended by blowing in at the *meseraic vein*; and from this difference of structure, the use of the *glandulae vagæ*, &c. can easily be assigned, viz. the *chyle* in these animals that have lacteals, being to be mixed with the blood in a considerable quantity at a time, lest its particles should attract one another strongly, and so hinder this mixture; it was therefore necessary it should be well diluted by the *humores iniquilini*, which bear a very great proportion to the quantity of pure *chyle*; since the *lymph* from the inferior extremities, *abdominal viscera*, neck, &c. are poured into it. Here there was no hazard of any such inconvenience by the *chyle* being mixed with the blood in small proportion from the immense number of the small extremities of the *meseraic veins*.

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The *pancreas* in the creature lies betwixt the two folds of the *duodenum*, and sends two or three *ducts* into this gut pretty near the *biliary*.

The *spleen* is here of a round globular figure, situated between the liver and stomach, and betwixt these and the back bone it enjoys the same properties as in other animals, *viz.* large blood vessels, &c. All its blood is sent into the *vena portarum*, and has a perpetual conquassation. It has excretory as far as we know. Their liver is divided into two equal lobes by a *pellucid membrane*, running according to the length of their body; and hence we may observe, that it is not proper to that bowel to lie on the right side, which is still more confirmed by what we observe in fishes, where it almost lies in the left side.

The shape of their gall-bladder is not much different from that of *quadrupeds*, but is thought to be longer in proportion to the size of the animal, and is farther removed from the liver; though in fishes it is still further removed, not being at all contiguous; and in them the *ductus hepaticus* and *cysticus* do not unite till just at the entry into the gut. In these animals, *viz.* fishes, there seems to be no way of the bile getting into the gall-bladder but by regurgitation.

The principal difference to be remarked in their heart is the want of the *valvulae tricuspides*, and their place being supplied by one fleshy flap.

The lungs are not loose within the cavity of the *thorax*, but fixed to the bone all the way; neither are they divided into lobes, as in those animals that have a large motion in their *spine*. They are two red spongy bodies covered with a *membrane* that is pervious, and communicates with the large *vesicles* or air bags that are dispersed over their whole *abdomen*, which *vesicles* serve two very considerable uses; the one is to render their bodies specifically light, when they have a mind to ascend and buoy themselves up when flying, by distending their lungs with

with air, and also straiten their *trachea arteria*, and so return the air.

Secondly, they supply the place of a *muscular diaphragm* and strong *abdominal muscles*; producing the same effects on the several contained *viscera*, as these muscles would have done without the inconveniency of their additional weight; and conduced as much to the exclusion of the egg and *fæces*.

The *trachea arteria*, near where it divides, is very much contracted, and their voice is principally owing to this coarctation. If you listen attentively to a cock crowing, you will be sensible that the noise does not proceed from their throat, but deeper; nay this very pipe, when taken out of their body and cut off a little, after its division, and blown into, will make a squeaking noise, something like the voice of these creatures. On each side, a little higher than this contraction, there is a muscle arising from their *sternum*, which dilates the *trachea*. The *cartilages*, of which the pipe is composed in this animal, go quite round it; whereas in men and *quadrupeds*, they are discontinued for about one fourth on the back part, and the intermediate space filled up by a *membrane*. Neither is the *trachea* so firmly attached to their *vertebrae* as in other creatures we have examined. This structure we shall find of great service to them, if we consider, that had the same structure obtained in them as in us, their breath would have been in hazard of being stopped at every flexion or twisting of their neck, which they are frequently obliged to. This we may be sensible of by bending our necks considerably on one side, upon which we shall find a great straitness and difficulty of breathing; whereas their *trachea* is better fitted for following the flexions of the neck by its loose connection to the *vertebrae*: and as from the structure of the *trachea* it cannot yield to every cause distending the *œsophagus* as in us, it was proper they should be placed at a greater distance from each other, which we accordingly find they are.

In place of a *muscular diaphragm*, this creature has nothing but a thin *membrane* connected to the *pericardium*, which separates the *thorax* and *abdomen*. But besides this, the whole *abdomen* and *thorax* are divided by a longitudinal *membrane* or *mediastinum* connected to the lungs, *pericardium*, liver, stomach, and to the fat lying over their stomach and guts, which is analogous to an *omentum*, and supplies its place.

The kidneys lie in the hollow excavated in the side of the back-bone, from which there is sent out a blueish coloured canal, running along by the side of the *vas deferens*, and terminates directly into the common *cloaca*. This is the *ureter*, which opens by a peculiar aperture of its own, and not at the *penis*. This creature having no *vesica urinaria*, it was thought by some they never passed any urine, but that it went to the nourishment of the *feathers*, but this is false; for that whitish substance that you see their greenish *fæces* covered with, and which turns afterwards chalky, is their urine. Let us next consider the organs of generation of both sexes, and first those of the male.

The *testicles* are situated one on each side of the back-bone, and are proportionally very large to the creature's bulk. From these run out the *vasa seminifera*, at first straight, but after they recede farther from the body of the *testicle*, they acquire an undulated or convoluted form, as the *epididymis* in man. These convolutions partly supply the want of *vesiculae seminales*, their portion being at the same time very short; these terminate in the *penis*, of which this creature has two, one on each side of the common *cloaca*, pointing directly outwards, and are very small and very short, hardly so big as a millet seed; whence they have escaped the notice of anatomists, who have often denied their existence. This is what is chiefly remarkable in the organs of the male.

The *racemus vitellorum* being analogous to the *ovaria* in the human subject, are attached by a proper

membrane to the back-bone. This is very fine and thin, and continued down to the *uterus*. Its orifice is averse with respect to the *ovaria*, yet notwithstanding, by the force of the *orgasmus venereus*, it turns round and grasps the *vitellus*, which in its passage through this *duct*, called the *infundibulum*, receives a thick gelatinous liquor, secreted by certain glands. This, with what it receives in the *uterus*, compose the white of the egg. By this tube then it is carried into the *uterus*.

The *uterus* is a large bag, placed at the end of the *infundibulum*, full of wrinkles on its inside; here the egg is completed, receiving its last *involutrum*, and the shell is at last pushed out at an opening in the side of the common *cloaca*. From the *testes* in the male being so very large, in proportion to the body of the creature, there must necessarily be a great quantity of *semen* secreted; hence the animal is salacious, and becomes capable of impregnating so many females. The want of the *vesiculae seminales* is in some measure supplied by the convolutions of the *vasa deferentia*, and by the small distance betwixt the secreting and excretory organs. The two *penes* contribute also very much to their short coition, at which time the opening of the *uterus* into the *cloaca* is very much dilated, that the effect of the *semen* on the *vitelli* may be the greater.

A hen will of herself indeed lay eggs, but these are not impregnated, and yet appear entirely complete, except that the small black spot, which comes afterwards to be the rudiments of the chick, is not here to be observed. After having observed the contents of the *abdomen* and *thorax*, we next proceed to examine the parts about the neck and head.

These creature, as was observed of fowls in general, have no teeth, which would have been needless, as they swallow their food entire; but their tongue is made pretty firm, lest it should be hurt by the sharp points of the grain they feed on. It is of a triangular figure, and pointed before; and as by the depending posture

posture their meat is in hazard of falling out of their mouths; to prevent this, there are several small pointed *papille* standing out upon their tongue and palate, with their points inclined backwards, allowing an easy passage to the food, but hindering its return.

We have here no *velum palatinum, uvula* or *epiglottis*, and in place of two large holes opening into the nose, there is only a long narrow *rima* supplied with pretty strong muscles, and such another supplies the place of a *glottis*. The creature has a power of shutting both at pleasure, and the nature of their food seems not only to exempt them from the hazard of its getting into the nose or *trachea*, but its sharp points would hurt an *uvula*, or *epiglottis*, if they had any. Hence we see with what difficulty they swallow dough or other sort of food that can be easily moulded into any form,

Their *cranium* is more *cellular* and *cavernous* than ours; by this means their heads are light, yet strong enough to resist external injuries; for the enlarging the diameter of the bones contributes to their strength. By this *cavernous cranium* the organ of smelling is considerably enlarged; and further, singing birds, as is observed by Mr Ray and Mr Derham, have this *cavernous* structure of the brain still more observable; and we are told that the cavity of the *tympanum* communicates with the cells; but this I am apt to believe, so far as I could find from dissection, is rather founded on theory than matter of fact. Their brain is covered with the common *membranes*, but its external surface is not formed into so many *gyræ* or convolutions, as ours. Its anterior part is quite solid, of a cineritious colour, and so far has a resemblance of the *corpora striata*, as to give rise to the *olfactory nerves*. The whole of it appears to us as imperfect, and we can scarce determine whether there be any thing analogous to a third or fourth ventricle; neither the *corpus callosum, fornix, notes, or testes*, &c. can be observed here; which parts therefore cannot be imagined as absolutely necessary

cessary for the functions of life, since we find these creatures perform them sufficiently well. We may perhaps think these serve a particular use in man, who is a rational creature, but then *quadrupeds* enjoy them in common with man. These protuberances, &c. seem rather to depend on the different disposition of the several parts, being variously connected and meeting in different directions in different places, than their being absolutely necessary for any particular use, and the uses that have been assigned to different parts of the brain by authors, seem to me to have no foundation but in the author's fancy. I have already owned my ignorance of the uses of the particular parts of the brain, so shall not pretend to give reasons for their being different in different animals, but all seem to agree in this, that the *cerebrum* has always hollows and vacuities in it, but the *cerebellum* none.

Their organ of smelling is very large and well provided with nerves; hence they have this sensation very acute. Ravens and other birds of prey give a sure proof of this by their being able to find out their prey though concealed from their sight, and at a considerable distance.

Those birds that grope for their food in the waters, mud, &c. have large nerves which run quite to the end of their bills, by which they find out and distinguish their food.

The anterior part of their eyes (instead of having the *sclerotic* coat continued, so as to make near a sphere as in us) turns all of a sudden flat; so that here the *sclerotic* makes but half a sphere; and the *cornea* rises up afterwards, being a portion of a very small and distinct sphere; so that in these creatures there is a much greater difference betwixt the *sclerotic* and *cornea* than in us. Hence their eyes do not jut out of their heads as in man and *quadrupeds*. As most of these creatures are continually employed in hedges and thickets, therefore that their eyes might be secured from these injuries, as well as from too much light when flying in the face of the sun, there is

a very elegant mechanism in their eyes, which is a *membrane* rising from the internal *canthus* of the eye; which at pleasure, like a curtain, can be made to cover the whole eye, and this by means of a proper muscle that rises from the *sclerotic coat* and passing round the *optic nerves* runs through the *musculus oculi attollens* (by which however the *optic nerves* are not compressed) and *palpebra* to be inserted into the edge of this *membrane*. Whenever this muscle ceases to act, the *membrane* by its own elasticity again discovers the eye. This covering is neither *pellucid* nor *opaque*, both which would have been equally inconvenient, but being somewhat transparent, allows as many rays to enter as to make any object just visible, and is sufficient to direct them in their progression. By means of this *membrane* it is said that the eagle is said to look at the sun. *Quadrupeds*, as we mentioned before, have a *membrana nictitans*; but then it only can cover that part of the eye which is never covered by their eye-lids.

Besides, all fowls have another particularity, whose use I think is not so well understood, and that is a pretty long black triangular purse rising from the bottom of their eye just at the entry of the *optic nerve*, and stretched out into their vitreous humour, and one would imagine it gave some threads to the crystalline. This the French (who as far as I know, were the first who took notice of it in their dissections before the Royal Academy) give the name of *bourse noire* to. This may possibly serve to suffocate some of the rays of light, that they may see objects more distinctly without hurting their eyes. It has a connection with the vitreous, and seems to be joined also to the crystalline humour. If we suppose it to have a power of contraction, (which may be as well allowed as that of the *iris*) it may so alter the position of the vitreous and crystalline humours, that the rays from any body may not fall perpendicularly upon the crystalline, and this seems to be necessary in them, since they cannot change the figure of the anterior part of their eye so much as we can do; and as this animal

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is exposed often to too great a number of rays of light, so they having no *tapetum*, have the bottom of their eye wholly black on the *retina*, and in consequence of this fowls see very ill in the dark.

They have no external ear, but in place thereof a tuft of very fine feathers covering the *meatus auditorius*, which easily allow the rays of sound to pass them, and likewise prevent dust, or any insect from getting in. An external ear would have been inconvenient in their passing through thickets and in flying, &c. A liquor is separated in the external part of the ear or *meatus auditorius* to lubricate the passage, and further prevent the entrance of any insects, &c. The *membrana tympani* is convex externally, and no muscles are fixed to the bones of their ear, which are rather of a cartilaginous consistence; any tremulous motions impressed on the air are communicated in these creatures, merely by the spring and elasticity of these bones, so probably the membrane is not so distended as in the human ear, where this is done by muscles. The *cotylea* and *semicircular canals* are very distinct and easily prepared.

The Anatomy of a carnivorous Fowl.

WE come next to the birds of prey, and for an example shall take a stenhil. The principal difference to be observed in them, is in their *chylopoietic viscera*, which may be accounted for from their different way of life.

Immediately under their *clavicles*, you will observe the *oesophagus* expanded into their *ingluvies*, which is proportionally less than in the *granivorous* kind, since their food does not swell so much by maceration, and for the same reason, there is a less quantity of a *menstruum* to be found here.

They have also a *ventriculus succenturiatus* plentifully stored with glands, situated immediately above their stomach, which we see here is evidently membranous,

branous, otherwise than in the *granivorous* kind, and this difference, which is almost the only one we shall find betwixt the two different species of fowls, is easily accounted for from the nature of their food, which requires less attrition, being easier of digestion than that of the other kind; nevertheless it seems requisite it should be stronger than the human, to compensate the want of *abdominal* muscles, which are here very thin.

The same mechanism obtains in this creature's *dum-denum*, that we have hitherto observed. As being a *carnivorous* animal its guts are proportionally shorter than those of the *granivorous* kind, for the reason first given, viz. its food being more liable to corrupt, therefore not proper to be long detained in the body, and for that reason it has no *intestina cœca*, of which the other species of fowls have a pair. The difference in their wings, backs and claws are obvious, and have been already in some measure observed.

There is a full description of the different parts of the egg, with the changes that happen in the time of incubation, in the second volume of the *Medical Essays*.

The Anatomy of Fishes.

A Queous animals are generally divided into such as have lungs, and such as want them. The first species differ very inconsiderably from an ox or any other *quadruped*, and are not easily procured, so that all I have to say on fishes, shall be taken from that species, which is not provided with respiratory organs.

Of these we may first observe, that they have a very strong thick *cuticle* composed evidently of a great number of scales laid one on another like the tiles of houses; this among other arguments serves to prove the human *epidermis* to be of a squamous structure.

structure. In the next place these creatures have neither anterior nor posterior extremities, as quadrupeds and fowls : For their progression is performed in a different way from either of these species of animals ; for this purpose they are provided with machines properly consisting of a great number of elastic beams, connected to one another by firm membranes, and with a tail of the same texture ; their spine is very moveable towards the posterior part, and the strongest muscles of their bodies are inserted there. Their tails are so framed as to contract to a narrow space when drawn together to either side, and to expand again when drawn to a straight line with their bodies, so by the assistance of this broad tail, and the fins on their sides, they make their progression much in the same way as a boat with oars on its sides and rudder at its stern. The perpendicular fins situated on the superior part of their body keep them in *aequilibrium*, hindering the belly from turning uppermost, which it would readily do, because of the air bag in the *abdomen* rendering their belly specifically lighter than their back, but by the resistance these fins meet with when inclined to either side, they are kept with their backs always uppermost. The best account of this matter we have in the treatise before mentioned, viz. *Borelli de Motu Animalium*, part I. chap. 23.

It may be next observed, that these creatures have nothing that can be called a neck, seeing they seek their food in an horizontal way, and can move their bodies either upwards or downwards as they have occasion by the contraction or dilatation of their air bag ; a long neck, as it would hinder their progression, would be very disadvantageous in the element they live in.

The *abdomen* is covered on the inferior part with a black-coloured thin membrane resembling our *peritoneum*. It is divided from the *thorax* by a thin membranous partition which has no muscular appearance,

so that we have now seen two different sorts of animals that have no muscular *diaphragm*.

These creatures are not provided with *teeth* proper for breaking their aliment into smaller morsels, as the food they use is generally small fishes or other animals that need no trituration in the mouth, but spontaneously corrupt and gradually dissolve into a liquid *chyle*. Their *teeth* serve to grasp their prey and hinder the creatures they have once catched from escaping again. For the same purpose the internal *cartilaginous* basis of the *bronchi*, and the two round bodies situated in the posterior part of the jaws, have a great number of tenter-hooks fixed into them in such a manner, as that any thing may easily get down, but is hindered to get backwards. The water that is necessarily taken in along with their food in too great quantities to be received into their jaws in deglution, passes betwixt the *interstices* of the *bronchi*, and the flap that covers them. The compression of the water on the *bronchi* is of considerable use to the creature, as we shall explain by and by.

The *oesophagus* in these creatures is very short, and scarcely distinguished from their stomach, seeing their food lies almost equally in both. The stomach is of an oblong figure. There are commonly found small fishes in the stomach of large ones, still retaining their natural form, but when touched they melt down into a jelly. From this and the great quantity of liquors poured into their stomachs, we may conclude that digestion is solely brought about in them by the dissolving power of a *menstruum*, and that no trituration happens here.

The guts in these animals are very short, making only three turns, the last of which ends in the common *claca* for the *faeces*, *urine* and *semen*, situated about the middle of the inferior part of their bodies.

What I call *pancreas*, some gave the name of *intestinula ceca* to ; it consists of a very great number of small threads, like so many little worms, which all terminate

terminate at last in two larger canals, that open into the first gut, and pour into it a viscid liquor, much about the place where the biliary ducts enter. Their intestines are connected to the back bone by a membrane analogous to a mesentery. No lacteals have been yet observed, and it is probable their aliment is taken in by the mesenteric veins.

Their liver is very large, of a whitish colour, and lies almost in the left side wholly, and contains a great deal of fat.

The gall-bladder is situated a considerable way from the liver, and sends out a canal, the *cystic duct* which joins with the *hepatic duct* just at the entry into the gut; some fibres are stretched from the liver to the gall-bladder, but none that I know of have hitherto discovered any cavity in these cords; so in this animal it should seem impossible that the bile can be carried into the gall-bladder in the ordinary way, and consequently must either be secreted on the sides of that sac, or regurgitate into it from the *canalis chole-dochus*.

The *spleen* is placed near the back-bone, and at a place where it is subjected to an alternate pressure from the constriction and dilatation of the air-bag, which is situated in the neighbourhood. Since in all the different animals we have dissected, we find the *spleen* attached to somewhat that may give it a conquassation, as in the human subject and quadrupeds, it is contiguous to the *diaphragm*, in fowls it is placed betwixt the back-bone, the liver and stomach, in fishes it lies on the *viscera arias*, and since we find it so well served with blood-vessels, and all its blood returning into the liver, we must not conclude the *spleen* to be an *inutile pondus*, only to serve as a balance to the animal *pro aequilibrio*, but particularly designed for preparing the blood to the liver.

The only organs of generation in this animal are two menstrual bags situated in the *abdomen* uniting near the *podex*. These in the male are filled with a whitish

whitish firm substance called the *milt*, and in the female with an infinite number of little *ova* clustered together, of a reddish yellow colour called the *roe*. Both these at spawning time we find very much distended, whereas at another time the male organs can scarce be distinguished from the female, nor is there any proper instrument in the male for throwing the seed into the organs of the female as in other creatures. I shall not take upon me to determine the way whereby the female sperm is impregnated, but we find that the spawn of frogs consists in the small specks wrapt up in a whitish glutinous liquor; these specks are the rudiments of the young frogs which are nourished in that liquor, till they are able to go in search of their food. In the same way the *ova* of fishes are thrown out and deposited in the sand, the male being for the most part ready to impregnate them, and they are incubated by the heat of the sun. It is curious enough to remark with what care they seek for a proper place to deposite their *ova*, by swimming to the shallow, where they can better enjoy the sun's rays, and shun the large jaws of other fishes. The river fishes again spawn in some creek free from the hazard of the impetuous stream. But whether this mixture be brought about in fishes by a simple application of the genitals to each other, or if both of them throw out their liquors at the same time in one place, and thus bring about the desired mixture, is not easy to determine; the latter I think, seems most probable. These creatures are so shy that we cannot possibly get to observe their way of copulation, and are consequently but little acquainted with their natural history.

After raising up the black *peritoneum*, there comes in view an oblong white membranous bag, in which there is nothing contained but air. This is the swimming-bladder; it lies close to the back-bone, and has a pretty strong muscular coat, whereby it can contract itself. By contracting this bag, they can make the muscles specifically heavier than water,

and so readily fall to the bottom ; whereas the *muscular fibres* ceasing to act, they become specifically lighter than water, and so swim above. According to the different degrees of contraction and dilatation of this bladder, they can keep higher or lower in the water at pleasure. Hence flounders, soles, raia and such other fishes as want this *sac*, are found always groveling at the bottom of the water : It is owing to this that dead fishes (unless this *membrane* has been previously broke) are found swimming a-top, the *muscular fibres* then ceasing to act, and that with their bellies uppermost ; for the back-bone cannot yield, and the distended *sac* is protruded into the *abdomen* and the back is consequently heaviest at its upper part according to their posture. There is here placed a glandular substance containing a good quantity of red blood, and all the red in their body is contiguous to this air-bag, excepting the guts. From the anterior part of the bag go out two *processes* or *appendices*, which, according to the gentlemen of the French Academy, terminate in their fauces : but I never could find out this communication either by tracing them, pouring in mercury or water, &c. I put, it is true, a probe through them, but then with the same strength I could have put it through the sides of the *processes*, so that I am afraid this is *gratis dictum*, and that there is here as in some other places of the human body an *aer insitus*.

At the superior part of this bag there are other red coloured bodies, of a glandular nature, which are connected with the kidneys. From them the *ureters* go down to their insertion in the *vesica urinaria*, which lies in the lower part of the *abdomen*, and the *urethra* is there produced, which terminates in the *pedex*.

These last mentioned parts have not hitherto been observed in some species of fishes, whence authors too hastily denied them in all. These creatures have a membranous diaphragm which forms a *sac*, in which

the heart is contained. It is very tense, and almost perpendicular to the *vertebræ*.

The heart is of a triangular form, with its base downwards, and its *apex* uppermost, which situation it has because of the *branchia*. It has but one *auricle* and one *ventricle*, because they want lungs; and one great artery. The size of the *auricle* and *ventricle* are much the same; the artery sends out numberless branches to the *branchia* or gills.

The *branchia* lie in two large slits at each side of their heads, and seem to be all they have that bears any analogy to lungs. Their form is semicircular; they have a vast number of *red fibrille* standing out on each side of them, like a fringe, and very much resemble the vane of a feather. These *branchia* are perpetually subjected to an alternate motion and pressure from the water; and we may here remark, that we have not found any *red blood* but in places subjected to this alternate pressure; this observation will help us in explaining the action of the lungs upon the blood. Over these gills there is a large flap, allowing a communication externally, by which the water they are obliged to take into their mouths with their food, finds an exit without passing into their stomach; it is owing to these flaps coming so far down that the heart is said commonly to be situated in their heads.

Their brains are formed pretty much in the same way as that of fowls, only we may observe that the posterior lobes bear a greater proportion to the anterior.

Their organ of smelling is large, and they have a power of contracting and dilating the entry into their nose as they have occasion. It seems to be mostly by their acute smell that they discover their food; for their tongue seems not to have been designed for a very nice sensation, being of a pretty firm cartilaginous substance, and common experiment evinces that their sight is not of so much use to them as their smell in searching for their nourishment. If you

throw a fresh worm into the water, a fish shall distinguish it at a considerable distance, and that this is not done by the eye, is plain from observing, that after the same worm has been a considerable time in the water and lost its smell, no fishes will come near it; but if you take out the bait and make several little incisions into it, so as to let out more of the odoriferous effluvia, it shall have the same effect as formerly. Now it is certain, had the creatures discovered this bait with their eyes, they would have come equally to it in both cases: In consequence of their smell being the principal means they have of discovering their food, we may frequently observe their allowing themselves to be carried down with the stream, that they may ascend again leisurely against the current of the water; thus the odorous particles swimming in that medium being applied more forcibly to their smelling organs, produce a stronger sensation.

The optic nerves in these animals are not confounded with one another in their middle progress betwixt their origin and the orbit, but the one passes over the other without any communication, so that the nerve that comes from the left side of the brain goes distinctly to the right eye: And vice versa.

The *lens crystallina* is here a compleat sphere, whereas in men and all other terrestrial animals it consists of two portions of unequal spheres laid on one another; to account for this, it must be considered that these creatures have got no aqueous humour, as the rays that come to their eyes are conveyed through a *medium* of the same density with that humour in other animals, and consequently would have gone on in a straight line without any refraction till they came to the *lens*, although they had been provided with an aqueous humour; thus then the rays impinging upon their *lens* have hitherto suffered no refraction; that they might therefore be sufficiently refracted and meet in a point on the *retina*, it was necessary the *lens* should be made more convex

convex than it is in other creatures who have the rays considerably refracted in their passage from the air through the aqueous humour.

As fishes are continually exposed to injuries in the uncertain element they live in, and as they are in perpetual danger of becoming a prey to the larger ones, it was necessary their eyes should never be shut, and in consequence of this they are not provided with *palpebrae*; but then as in the current itself the eye must be exposed to several injuries, there was a necessity it should be sufficiently defended, which in effect it is by a firm *pellucid membrane* that seems to be a continuation of the *cuticula*, being stretched over here. The *epidermis* is very proper for this purpose, as being insensible and destitute of vessels, and consequently not liable to obstructions, or by that means, of becoming opake.

Whether fishes have a sense of hearing or not, is very uncertain: All that has the appearance of an organ of hearing in these creatures is a bone, about the bulk of one half of a common bean of a particular structure, being very brittle and composed of a great many different *segments* laid at one another's sides, and situated in a particular form at the side of the brain; is then the idea of sound communicated to them by means of this bone? Or does their running away, at stamping hard on the ground or crying loud, depend, upon some other kind of sensation? This may possibly be produced in them, by a tremulous motion communicated to their bodies by the circumambient water, which is put in agitation, from the like concussions happening in the air or neighbouring ground.

